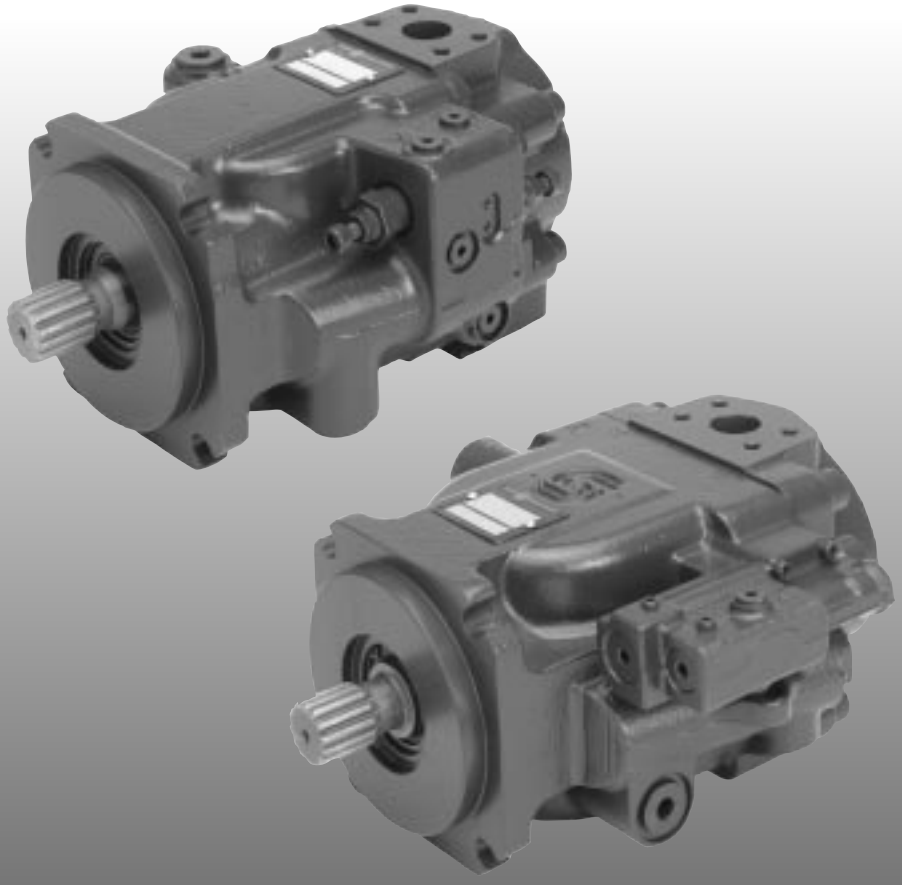
SAUER SUNDSTRAND

Series 45



Axial Piston

Open Circuit Pumps

Service Manual

1. Introduction

1.1 Using This Manual

This manual includes information for the normal operation, maintenance, and service of the Series 45 family of open circuit pumps. The manual includes a description of the units and their individual components, troubleshooting information, adjustment instructions and minor repair procedures. Unit warranty obligations should not be affected if maintenance, adjustment and minor repairs are performed according to the procedures described in this manual.

Many service and adjustment activities can be performed without removing the unit from the vehicle or machine. However, adequate access to the unit must be available, and the unit must be thoroughly cleaned before beginning maintenance, adjustment, or repair activities. Since dirt and contamination are the greatest enemies of any type of hydraulic equipment, cleanliness requirements must be strictly followed. This is especially important when changing the system filter and during adjustment and repair activities.

A worldwide network of Sauer-Sundstrand Authorized Service Centers is available should repairs be needed. Contact any Sauer-Sundstrand Authorized Service Center for details. A list of all Service Centers can be found in bulletin BLN-2-40527, or in brochure SAW (Ident. No. 698266).

1.2 Safety Precautions

Always consider safety precautions before beginning a service procedure. Protect yourself and others from injury.

The following general precautions should be taken into consideration whenever servicing a hydrostatic system.

Disable Work Function

⚠ WARNING
Certain service procedures may require the vehicle / machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing them in order to prevent injury to the technician and bystanders.

Flammable Cleaning Solvents

⚠ WARNING
Some cleaning solvents are flammable. To avoid possible fire, do not use cleaning solvents in an area where a source of ignition may be present.

Fluid Under High Pressure

⚠ WARNING
Use caution when dealing with hydraulic fluid under pressure. Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury. This fluid may also be hot enough to cause burns. Serious infection or reactions can develop if proper medical treatment is not administered immediately.

Personal Safety

⚠ WARNING
Proper safety equipment, including safety glasses, should be used at all times.

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1.3 Symbols Used in Sauer-Sundstrand Literature

DANGER! May result in injury.

May result in immediate or premature damage.

Reusable part

Nonreusable part, use a new part.

Non-removable item

“OR” in drawing – either option may exist.

Measurement required.

Flatness specification

Parallelism specification

External hex head

Internal hex head

Torx head

Tip, helpful suggestion

Lubricate with hydraulic fluid.

Apply grease / petroleum jelly.

Apply locking compound.

Inspect for wear or damage.

Clean area or part.

Be careful not to scratch or damage.

Note correct orientation.

Mark orientation for reinstallation.

Torque specification

Press in.

Pull out with tool.

Use installation sleeve / cone "bullet".

The symbols above can be found in the illustrations and text of this manual. They are intended to communicate helpful information at the point where it is most useful to the reader.

In most instances, the appearance of the symbol itself denotes its meaning. The legend above is provided to define each symbol and explain its purpose.

2. Functional Description

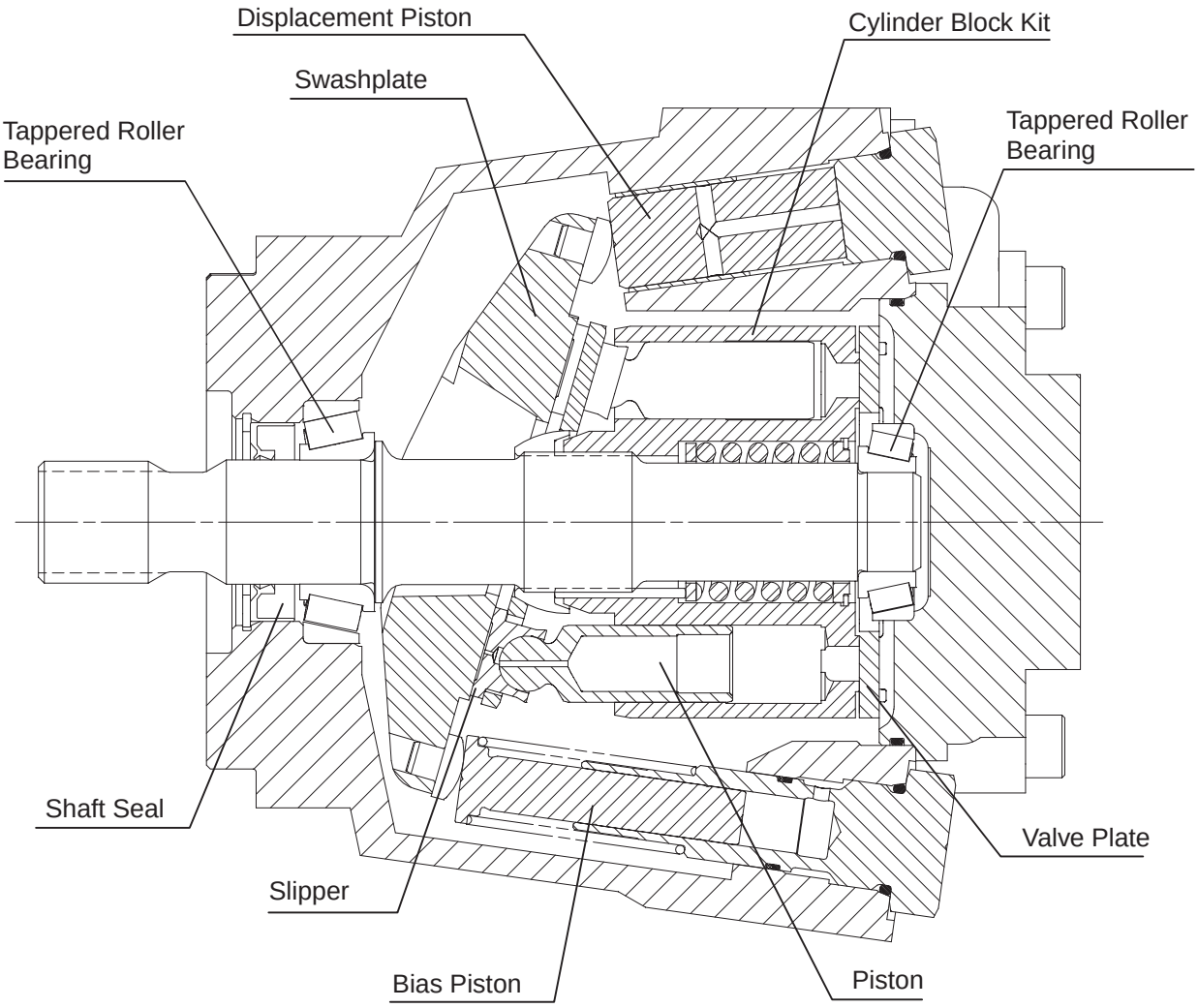
2.1 General Description and Cross Sectional Views

2.1.1 Open Circuit Pump Design

Sauer-Sundstrand Series 45 open circuit pumps convert input torque into hydraulic power. A rotating cylinder block containing axial pistons which are forced in and out of their bores by the angle of a swashplate, results in a specific amount of fluid being displaced for every revolution of the cylinder block.

The displacement per revolution will change as the swashplate angle changes. The swashplate angle is controlled by the displacement piston. The bias piston acts to return the pump swashplate to max angle.

The slipper attaches to the end of the piston by means of a ball and socket joint. This allows the slipper to tilt at any angle while maintaining contact with the swashplate. The face of the slipper pad slides on a hydrostatic fluid film which uses fluid pressure to balance internal forces.



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2.1 General Description and Cross Sectional Views (continued)

2.1.2 Basic Pump Operation

Series 45 pumps utilize a cradle swashplate design with a hydraulic control piston. Control is provided through a built-in compensator valve. This compensator will shift the pump displacement from maximum to minimum when the set pressure is reached. Controls are also available for remote compensators and load sensing systems. An available displacement adjustment screw allows the maximum flow to be adjusted to match system requirements. These controls are designed for low hysteresis and responsive performance.

2.2 The System Circuit

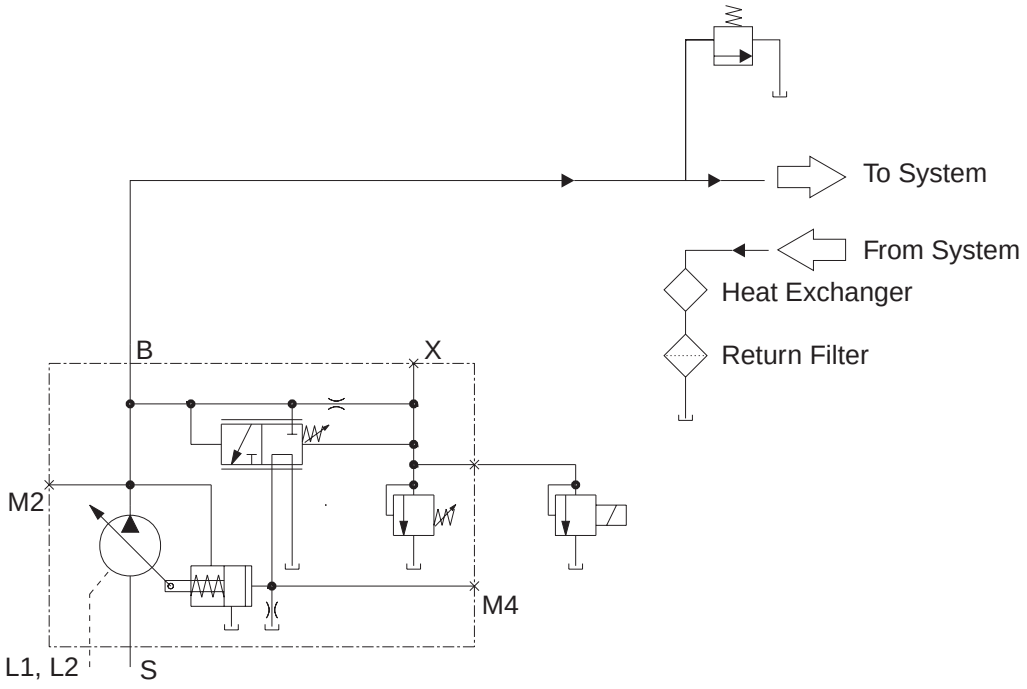
The pump receives fluid directly from the reservoir without the requirement of a charge pump. Fluid is then pumped under pressure to the system and returns directly to the reservoir.

The speed of the actuator (cylinder, hydraulic motor, etc.) depends on the volume of fluid being pumped. The operating pressure depends on the actuator load.

If the actuator is to be reversed, a direction control valve is necessary as the pump swashplate operates on one side of neutral only and the pump is unidirectional.

When the pump's automatic control is activated, fluid is ported to the displacement piston. This action destrokes the swashplate (reduces pump displacement) to obtain the desired pump flow.

The control can position the swashplate at any angle between it's maximum and zero displacement to provide the pump flow necessary to maintain the setting of the control.



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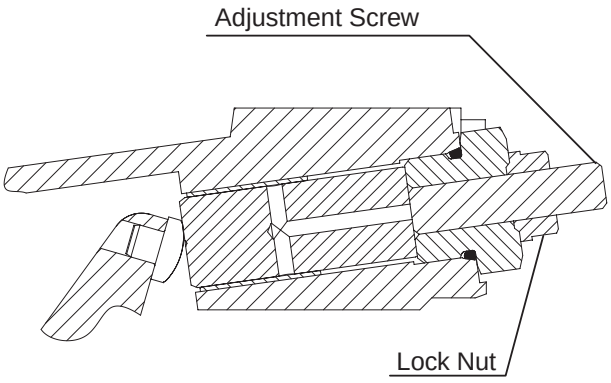
2.3 Pump Features

To meet the requirements of various applications, the Series 45 pumps are available with various options which change the operation of the pump.

2.3.1 Displacement Limiters

Series 45 pumps are available with an optional maximum displacement limiter. This mechanical stop can limit the maximum displacement of the pump to any value from maximum to 75% displacement.



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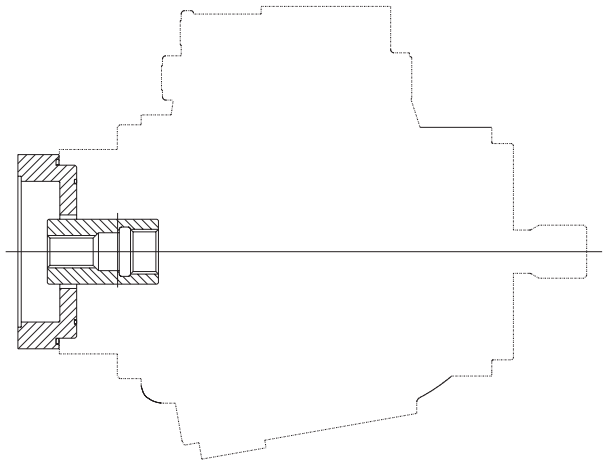
2.3.2 Auxiliary Mounting Pads

Auxiliary mounting pads are available for all **radial ported** Series 45 pumps. These pads are typically used for mounting auxiliary hydraulic pumps.

Since the auxiliary pad operates under case pressure, an o-ring must be used to seal the auxiliary pump mounting flange to the pad. The driving coupling is lubricated by oil from the main pump case.



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2.3.3 Input Shafts

Series 45 pumps are available with a variety of splined, straight keyed, and tapered end shafts.

2.5 Pump Control Options

2.5.1 Pressure Compensator (PC) Control

The pressure compensator control is designed to maintain a constant pressure in the hydraulic circuit as flow varies.

When the system pressure at the pump outlet drops below the compensator setting, the control will increase the pump displacement to maximum (maximum flow). Once the system pressure reaches the compensator setting, the control will regulate pump displacement to produce an output flow which will maintain system pressure at the compensator setting.

The pressure compensator setting is adjustable. The setting range for the pressure compensator is from 100 to 280 bar [1450 to 4060 psi]. *Refer to Section 8, page 22, for adjustment procedures.*

Note: On 57cc pumps built after serial number A-98-21-XXXXX, tamper resistant hardware is installed on the PC & second stage adjustment screws. This will allow only one complete clockwise turn from the original factory setting.

Gain - bar [psi] per turn		
	57 cc	**74 cc**
PC	88.94 [1290]	42.06 [610]
2nd Stage	17.93 [260]	----------

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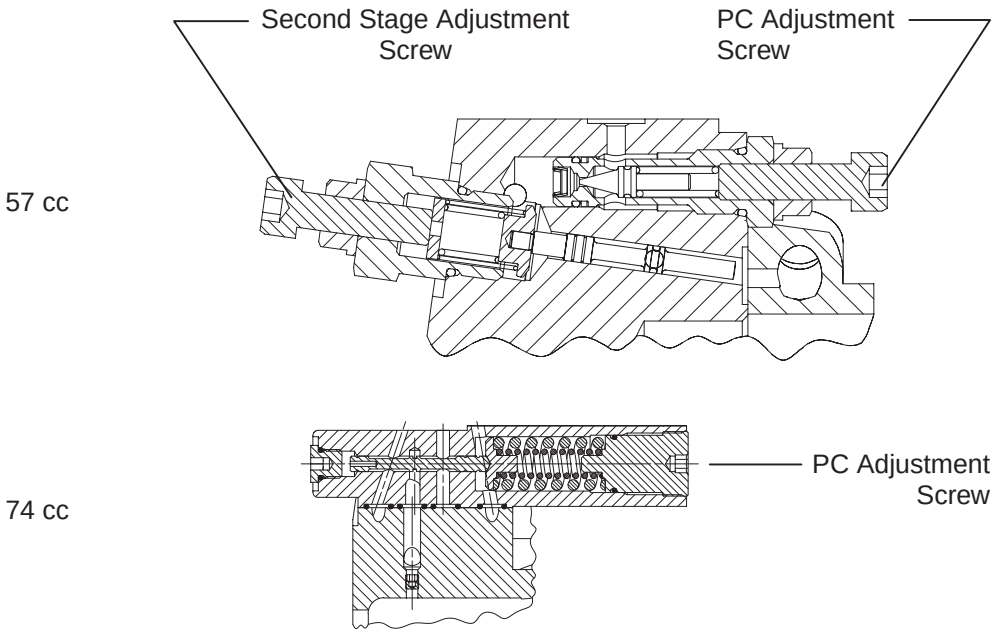

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2.5 Pump Control Options (continued)

2.5.2 Load Sensing (LS) Control

The load sensing control is designed to match pump outlet flow and pressure with system demand.

When the control valve is "centered," the load sensing port on the pump is drained to the reservoir through a bleed orifice located either in the control valve or the pump housing. This maintains a standby pressure at the pump outlet equal to the load sense setting.

When the external control valve is actuated, the load sensing port sees the load pressure. The pump control then adjusts the pump output flow to maintain a constant pressure drop (equal to the load sensing setting) across the external control valve. The pump thereby provides flow to the load as demanded by the external control valve position.

The load sensing setting is adjustable. The setting range for the load sensing control is from 10 to 30 bar [145 to 435 psi]. *Refer to section 8, page 24, for adjustment procedures.*

Gain - bar [psi] per turn		
	57 cc	**74 cc**
PC	88.94 [1290]	42.06 [610]
LS	17.93 [260]	17.24 [250]

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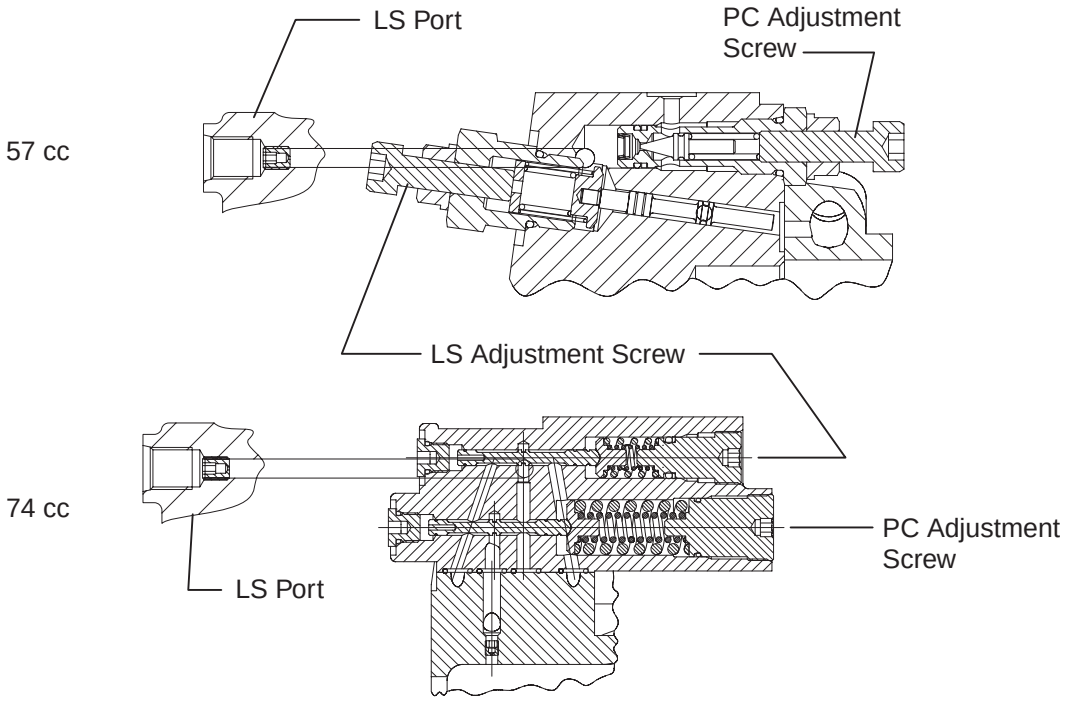
Note: On 57cc pumps built after serial number A-98-21-XXXXX, tamper resistant hardware is installed on both the PC & LS adjustment screws. This will allow only one complete counter clockwise turn from original factory setting.



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3. Technical Specifications

3.1 General Specifications

3.1.1 Design

Open circuit axial piston pumps of cradle swashplate design with variable displacement.

3.1.2 Type of Mounting

SAE flange, Size C (SAE J744) mounting pad
SAE flange, Size B optional for 57cc pump only

3.1.3 Auxiliary Mounting Pad Options

SAE flange, Size A, B, B-B, or C

3.1.4 Control Options

PC: Pressure Compensator
LS: Load Sensing (with Pressure Compensator)

3.1.5 Port Connections

Inlet and pressure ports: SAE Flange Ports, Code 61
Axial (end) ports or radial (side) ports All other: SAE straight thread o-ring boss

3.1.6 Direction of Rotation

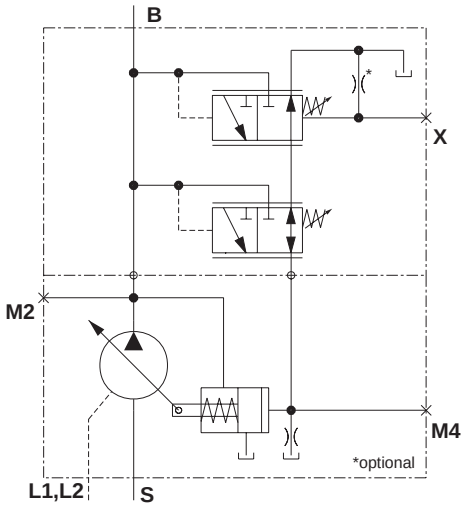
Clockwise or counterclockwise

3.1.7 Installation Position

Installation position discretionary. The housing must always be filled with hydraulic fluid.

3.2 Circuit Diagrams

Series 45 74 cc variable displacement pump with pressure compensator / load sensing control



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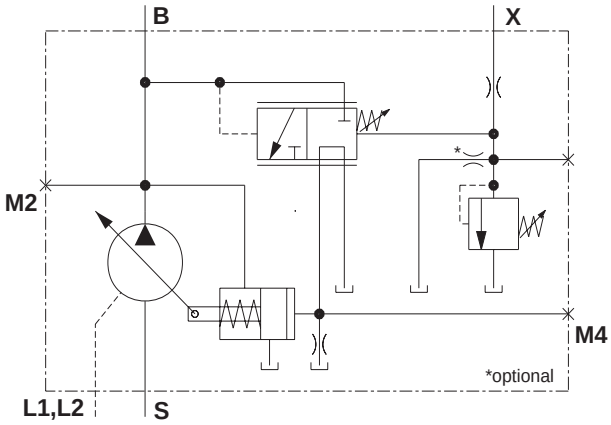
Ports:

B	=	Main pressure line
S	=	Suction line
L1, L2	=	Case drain lines
X	=	Load sense line
M2	=	Gauge port for port "B"
M4	=	Gauge port - servo pressure

Series 45 57 cc variable displacement pump with pressure compensator / load sensing control



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Ports:

B	=	Main pressure line
S	=	Suction line
L1, L2	=	Case drain lines
X	=	Load sense line
M2	=	Gauge port for port "B"
M4	=	Gauge port - servo pressure

3.3 Hydraulic Parameters

3.3.1 Inlet Pressure

Minimum pressure, continuous = 0.8 bar absolute [23.2 in Hg]
(at reduced maximum pump speed)

Minimum pressure, cold start = 0.5 bar absolute [14.8 in Hg]

3.3.2 Pressure Compensator Valve Setting

Minimum pressure: 100 bar [1450 psi]

Maximum pressure: 280 bar [4060 psi]

3.3.3 Case Pressure

Maximum continuous: 0.5 bar [7 psi] Above inlet
Intermittent: 2 bar [29 psi] Cold start

3.3.4 Hydraulic Fluid

Refer to Sauer-Sundstrand publication BLN-9887 or 697581. Refer to publication ATI-E 9101 for information relating to biodegradable fluids.

3.3.5 Temperature Range[1]

Intermittent, cold start	=	- 40° C [- 40° F]
Continuous	=	82° C [180° F]
Maximum	=	104° C [220° F]

(at the hottest point, i.e. drain line)

1. Hydraulic fluid viscosity must be maintained within the prescribed limits.

3.3.6 Fluid Viscosity Limits

mm^2/s (cSt)	SUS (Saybolt Universal Seconds)
ν min = 9	58 min. continuous
ν min = 6.4	47 intermittent
ν max = 110	500 max. continuous
ν max = 1000	4700 intermittent, cold start

3.3.7 Filtration

Required cleanliness level: ISO 4406 Class 18/13 or better. *Refer to Sauer-Sundstrand publication BLN-9887 or 697581 and ATI-E 9201.*

3.4 Technical Data

		Dimension	Frame Size	
			057	074
Displacement		cm^3 [in^3]	57 [3.48]	74 [4.52]
Input Speed	Minimum	min^{-1} (rpm)	500	500
	Rated*	min^{-1} (rpm)	2600	2400
	Maximum*	min^{-1} (rpm)	3200**	2800**
Maximum (Peak) Working Pressure		bar [psi]	350 [5075]	350 [5075]
Continuous Working Pressure		bar [psi]	280 [4060]	280 [4060]
Flow at Rated Speed		l/min [US gal/min]	148.2 [39.5]	177.6 [47.4]
Theoretical Input Torque at Maximum Displacement		Nm/bar [lbf·in/1000 psi]	0.907 [554]	1.178 [720]
Mass Moment of Inertia of the Internal Rotating Parts		$kg \cdot m^2$ [$lbf \cdot ft^2$]	0.0043 [0.1014]	0.0063 [0.1500]
Weight	Axial Ported Units	kg [lb]	24 [53]	29 [63]
	Radial Ported Units	kg [lb]	27 [60]	36 [80]

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* *Refer to General Technical Specifications in Series 45 Axial Piston Open Circuit Pumps Technical Information Manual, BLN-10128.*

** With pressurized inlet.

4. Pressure Measurement

4.1 Required Tools

The service procedures described in this manual for Series 45 pumps can be performed using common mechanic's hand tools. Special tools, if required are shown. Pressure gauges should be calibrated frequently to ensure accuracy. Snubbers are recommended to protect pressure gauges.

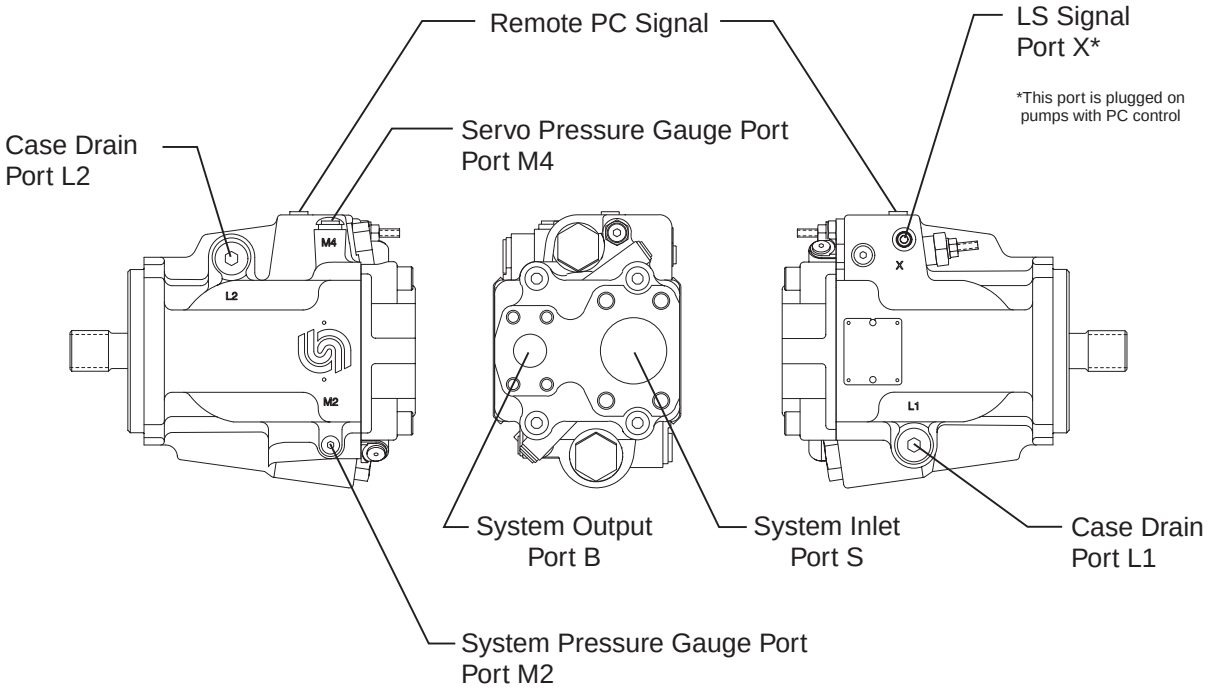
4.2 Port Locations and Pressure Gauge Installation

The following sections list the gauge ports for each frame size. The recommended pressure gauge and fitting are also specified. Outline drawings showing port locations follow the tables.

4.2.1 57 cc Frame Size

M2	System Pressure	300 bar or 5000 psi gauge 7/16 — 20 o-ring Fitting
M4	Control Piston	300 bar or 5000 psi gauge 7/16 — 20 o-ring Fitting

L1 L2	Case Pressure	10 bar or 100 psi gauge 7/8 — 14 o-ring Fitting (057)
X1	LS Signal	300 bar or 5000 psi gauge Tee into LS Signal Line 7/16 — 20 o-ring Fitting



Base Unit Shown with PC / LS Control and Axial End Cap Ports (LH Rotation)

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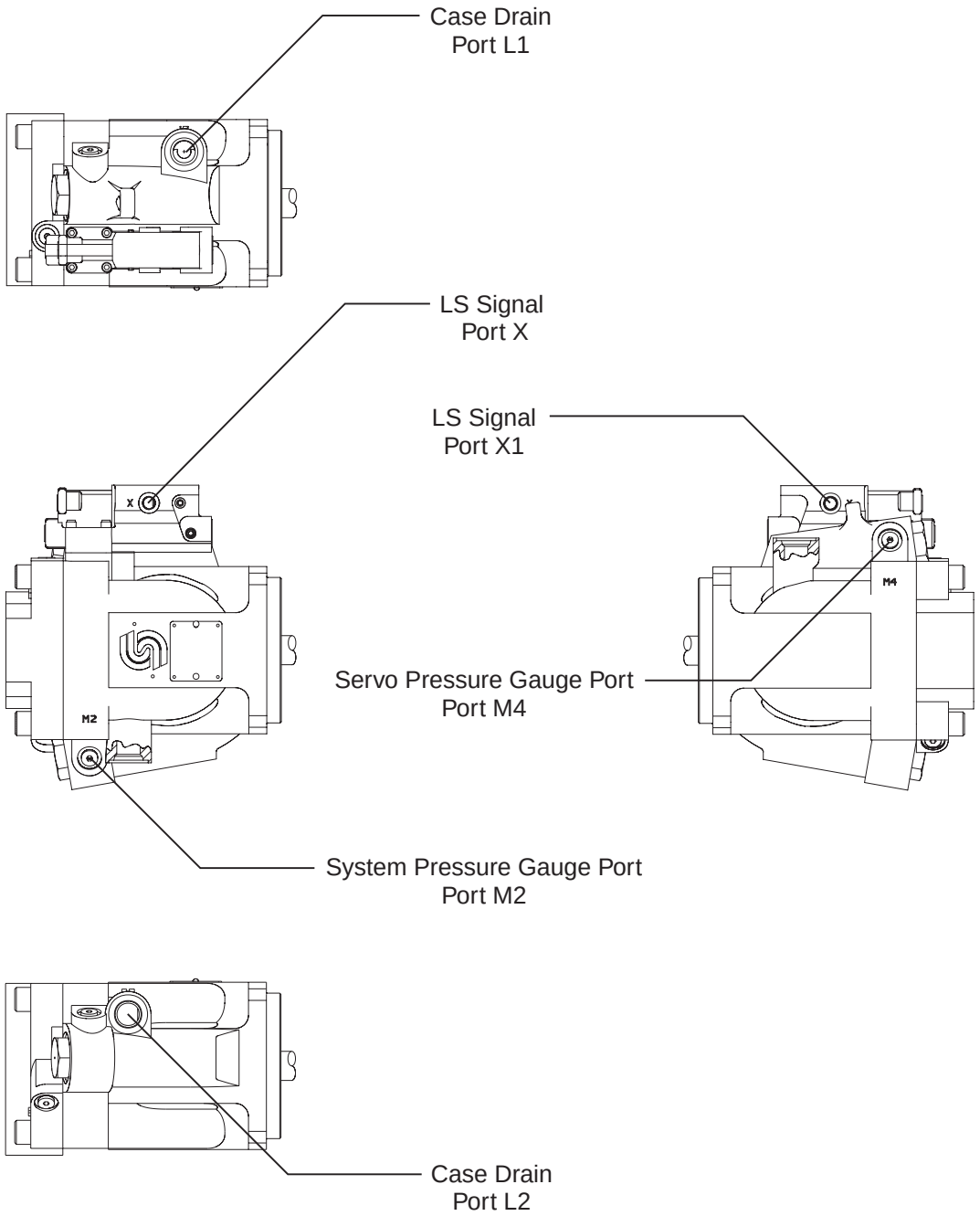
4.2 Port Locations and Pressure Gauge Installation (continued)

4.2.2 74 cc Frame Size

M2	System Pressure	300 bar or 5000 psi gauge 7/16 — 20 o-ring Fitting
M4	Control Piston	300 bar or 5000 psi gauge 7/16 — 20 o-ring Fitting

L1 L2	Case Pressure	10 bar or 100 psi gauge 7/8 — 14 o-ring Fitting (074)
X1	LS Signal	300 bar or 5000 psi gauge Tee into LS Signal Line 7/16 — 20 o-ring Fitting



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Base Unit with PC/LS Control and Axial End Cap Ports Shown

5. Initial Start-up Procedures

The following start-up procedure should always be followed when starting-up a new Series 45 installation or when restarting an installation in which the pump has been removed.

⚠ WARNING

The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders. Take necessary safety precautions before moving the vehicle/machine.

Prior to installing the pump, inspect the units for damage incurred during shipping and handling. Make certain all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

The pump should be connected to the prime mover so that the centers of both shafts are aligned. Incorrect alignment may result in eventual damage to the drive shaft, drive shaft bearings, or the drive shaft seal which can cause external oil leakage.

Fill the main pump housing with clean hydraulic fluid prior to start up. Fill by pouring filtered oil directly into the upper most case drain hole.

Fill the reservoir with recommended hydraulic fluid. Fluid should always be filtered through a 25 micron filter prior to entering the reservoir. Never reuse hydraulic fluid.

The inlet line leading from the pump to the reservoir must be filled prior to start up. Check inlet line for properly tightened fittings and be certain it is free of restrictions and air leaks.

To ensure the pump stays filled with oil, the case drain line should be installed in the upper most case drain port.

Follow recommendations in the vehicle / machine operator's manual for prime mover start up procedures.

Install a gauge at port M2 to monitor system pressure during start up.

Jog the prime mover or run at the lowest possible speed until system pressure builds to normal levels (minimum 11 bar [160psi]). Once system pressure is established, increase the speed to full operating RPM. If system pressure is not maintained, shut down the prime mover, determine the cause, and take corrective action. *Refer to Troubleshooting, page 18.*

Operate the hydraulic system for at least fifteen (15) minutes under light load conditions. It may be necessary to check and adjust control settings after installation. *Refer to Adjustments, page 22.* Shut down the prime mover and remove the pressure gauge. Check the fluid level in the reservoir, add if necessary.

The pump is now ready for operation.

6. Fluid and Filter Maintenance

To ensure optimum service life of Series 45 products, regular maintenance of the fluid and filter must be performed. Contaminated fluid is the main cause of unit failure. Care should be taken to maintain fluid cleanliness while performing any service procedure.

Check the reservoir daily for proper fluid level, the presence of water (noted by a cloudy to milky appearance or free water in the bottom of the reservoir), and rancid fluid odor (indicating excessive heat). If either of these conditions occur change the fluid and filter immediately.

It is recommended that the fluid and filter be changed per the vehicle / machine manufacturer's recommendations or at the following intervals:

Reservoir Type	Maximum Oil Change Interval
Sealed	2000 Hours
Breather	500 Hours

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It may be necessary to change the fluid more frequently if it becomes contaminated with foreign matter (dirt, water, grease, etc.) or if the fluid has been subjected to temperature levels greater that the recommended maximum. Never reuse hydraulic fluid.

Dispose of used hydraulic fluid properly.

Filters should be changed whenever the fluid is changed or whenever the filter indicator shows that it is necessary to change the filter. Replace all fluid lost during filter change.

7. Troubleshooting

7.1 Excessive Noise and / or Vibration

Item	Description	Action
1. Check oil in reservoir.	Insufficient hydraulic fluid will lead to cavitation.	Fill the reservoir to proper level.
2. Check for air in system.	Noisy, erratic control.	Purge air and tighten fittings. Check inlet for leaks.
3. Check pump inlet pressure / vacuum.	Erratic behavior, low output flow.	Correct pump inlet pressure / vacuum conditions.
4. Inspect shaft couplings.	A loose or incorrect shaft coupling will cause excessive noise and/or vibration.	Repair or replace coupling and check that correct coupling is being used.
5. Inspect shaft alignment.	Misaligned shafts will create excessive frictional noise and/or vibration.	Correct shaft misalignment.
6. Hydraulic oil improper viscosity.	Hydraulic oil viscosity above acceptable limits will cause cavitation at start up.	Replace existing fluid with the appropriate viscosity grade fluid. *See Hydraulic Fluids, Series 45 Technical Information Manual, BLN-10128.*

7.2 System Operating Hot

Item	Description	Action
1. Check oil in reservoir.	Insufficient amount of hydraulic oil will not meet cooling demands of system.	Fill the reservoir to proper level. Verify proper size of reservoir.
2. Inspect heat exchanger.	Heat exchanger not sufficiently cooling system.	Check air flow and input air temperature for the heat exchanger. Clean, repair, or replace heat exchanger. Verify proper size of heat exchanger.
3. Check external system relief valve setting.	Relief valve setting below PC setting will create heat.	Adjust external system relief valve setting.
4. Check pump inlet pressure/vacuum.	High inlet vacuum will create heat.	Correct inlet pressure / vacuum conditions.

7.3 Actuator Response is Sluggish

Item	Description	Action
1. Check external system relief valve setting.	Low external relief valve setting will slow down system.	Adjust external relief valve setting.
2. Check PC and LS control setting.	Low PC setting will prevent the pump from achieving full stroke.	Adjust PC and LS setting.
3. Check LS control signal pressures.	Incorrect LS signal will not allow pump to operate correctly.	Inspect system, ensure that proper LS signal is transmitted to the pump.
4. PC control not operating properly.	PC control with abnormal wear or contamination will not operate properly.	Flush screen in PC cartridge to remove contamination or replace abnormally worn spool.

7.3 Actuator Response is Sluggish (continued)

Item	Description	Action
5. Internal system leaks.	Worn internal parts will not allow the pump to operate properly.	Repair as required.
6. Hydraulic oil viscosity above acceptable limits.	Oil viscosity above acceptable limits or low oil temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures. *See Hydraulic Fluids, Series 45 Technical Information Manual, BLN-10128.*
7. Check system valving.	Malfunctioning valve may not allow system to respond.	Repair or replace system valving.
8. Check pump case pressure.	High case pressure will cause the system to be sluggish.	Correct case drain line restrictions.
9. Check pump inlet pressure / vacuum.	High inlet vacuum will cause cavitation and generate heat.	Correct inlet pressure conditions.

7.4 Low Pump Output Flow

Item	Description	Action
1. Check oil in reservoir.	Insufficient hydraulic oil level.	Fill the reservoir to proper level.
2. Hydraulic oil viscosity above acceptable limits.	Oil viscosity above acceptable limits or low oil temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures. *See Hydraulic Fluids, Series 45 Technical Information Manual, BLN-10128.*
3. Check external system relief valve setting.	External relief valve set below PC setting will cause low flow.	Correct external relief valve setting.
4. Check PC and LS control setting.	Low PC setting will prevent the pump from achieving full stroke. Low LS setting will prevent adequate flow.	Adjust PC and LS setting. *See Adjustments, page 22.*
5. Check pump inlet pressure / vacuum.	High inlet vacuum will cause cavitation and decrease flow.	Correct inlet pressure conditions.
6. Check input speed.	Low input speeds decrease flow.	Adjust input speed.
7. Check pump displacement limiter.	Pump displacement limiter may be set below desired flow rate.	Adjust displacement limiter to the appropriate setting. *See Adjustments, page 26.*
8. Check pump rotation.	Incorrect rotational configuration will cause low flow.	Use pump with appropriate rotational configuration.
9. Check pilot orifice in port X.	Restricted control orifice will limit output flow.	Inspect and clean control orifice.
10. Verify bleed orifice plug is installed (serial numbers prior to A-97-52-XXXX).	If plug is missing, control will not perform correctly.	Install bleed orifice plug (C111). *See Minor Repair page 33.*

7.5 Pressure Compensator Not Reaching PC Setting

Item	Description	Action
1. Check PC control setting.	Pump will not compensate to pressure settings.	Adjust PC to appropriate setting.
2. Check external relief valve.	PC control cannot be set above an external relief valve setting.	Adjust the external relief valve to the appropriate setting.
3. Inspect compensator spring.	Broken, damaged, or missing spring will cause erratic operation.	Replace spring.
4. Inspect PC poppet (57cc), or spool (74cc) for wear.	Abnormal wear of the PC poppet or spool will allow internal leakage in the control.	Replace PC cartridge or spool.
5. Inspect compensator spool.	Improper orientation will result in poor operation.	Correct orientation of spool.
6. Check PC control for contamination.	Spool or poppet is held open by contaminants.	Clean PC control components and rid system of contamination.
7. Verify bleed orifice plug is installed (serial numbers prior to A-97-52-XXXX).	If plug is missing, control will not perform correctly.	Install bleed orifice plug (C111). *See Minor Repair page 33.*

7.6 High Inlet Vacuum

Item	Description	Action
1. Check oil temperature.	Cold oil has a higher viscosity.	Allow system to warm up before operation.
2. Inspect inlet screen.	Restriction will cause high vacuum.	Remove restriction / blockage.
3. Check inlet piping.	Too many fittings, bends, or long piping will cause high vacuum.	Eliminate fittings to make path more direct.
4. Hydraulic oil improper viscosity.	Hydraulic oil viscosity above acceptable limits will cause cavitation.	Replace existing fluid with the appropriate viscosity grade fluid. *See Hydraulic Fluids, Series 45 Technical Information Manual, BLN-10128.*

7.7 Pressure or Flow Instability

Item	Description	Action
1. Air in system.	Air in system will cause erratic operation.	Activate PC, allowing system to bleed air. Check inlet line for leaks.
2. Check control spools.	Sticking control spools.	Inspect spools for free movement in bore. Clean or replace as needed.
3. Check external relief valve and PC setting.	Insufficient pressure differential between pump and external relief valve.	Adjust external relief valve or PC control settings to appropriate level.
4. Check external relief valve.	Chattering external relief valves may be causing unstable feedback to pump.	Adjust or replace relief valve.
5. Check gain orifice-plug (57 cc only).	Obstructed gain orifice-plug option may cause instability.	Clear or change gain orifice-plug.

Notes:

8. Adjustments

8.1 Pressure Compensator (PC) Control Adjustments

8.1.1 57 cc Frame Size

⚠ WARNING

Do not make adjustments or disconnect any hoses until all residual pressure in the system circuit has been released.

Take necessary precautions to secure the work function of the machine to prevent injury while performing this procedure.

The pressure compensator setting is indicated in the pump model code. *Refer to the Technical Information Manual BLN-10128 for more information.*

Install a pressure gauge in port M2 to measure system pressure. Install a pressure gauge in drain port L1 or L2 to measure case pressure. If a remote PC control is used, disconnect the signal line, cap it, and plug the port. *Refer to Pressure Measurement, page 14.*

Install a pilot hose (6mm [0.25 in] diameter minimum) at port X connecting to the reservoir to drain the remote PC port.

Note: Failure to drain port X (spring cavity) to reservoir may cause additional back pressure on the PC spring, resulting in pressure settings above the desired specification. It is recommended that this procedure be used on all Series 45, 57cc pumps, however it is particularly vital to 1999 and newer units due to hardware changes associated with the PC cartridge.

Start the prime mover and run at normal speed. While securing the second stage adjustment screw, loosen the seal locknut. Turn the second stage adjustment screw[1] until a the gauge at port M2[2] reads 15 bar [220psi]. Clockwise rotation of the screw will increase pressure, counterclockwise rotation will decrease.

While holding the position of the second stage adjustment screw, torque the seal locknut to 23 Nm [17 lbf•ft].

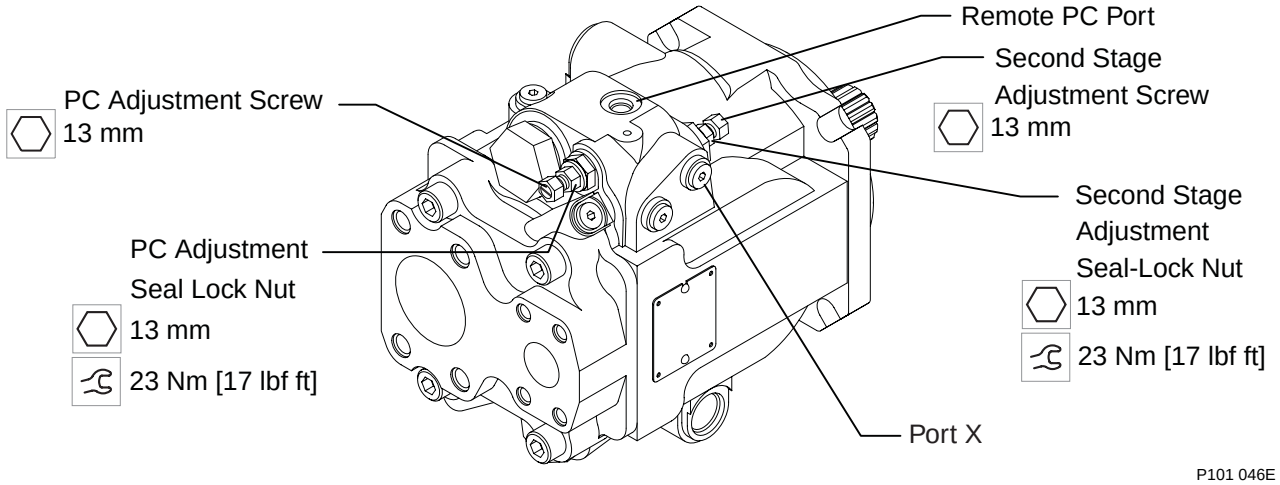
Shut down the prime mover. Disconnect the pilot hose installed at port X and reinstall the plug.

Start the prime mover and run at normal speed. Operate a hydraulic function to its full extension, loading the pump at maximum pressure and zero flow.

While securing the PC adjustment screw, loosen the seal locknut. Turn the PC adjustment screw[1] until the desired setting is indicated on the pressure gauge at port M2[3]. Clockwise rotation will increase pressure, counterclockwise rotation will decrease. If the pressure does not increase, an external system relief valve may need to be adjusted. An external system relief valve should be set above the PC setting for proper operation.

While holding the position of the PC adjustment screw, torque the seal locknut to 23 Nm [17 lbf•ft].

Stop the prime mover, remove the pressure gauges, and return the system to its normal operating configuration.



P101 046E

1. Pumps with serial number greater than A-98-21-XXXX will have tamper resistant hardware installed on both the PC and second stage adjustments. This will only allow one complete clockwise turn from the original factory setting.

2. The second stage setting is referenced to the pressure at port X. During this procedure port X is vented to reservoir.

3. PC setting is referenced to case pressure. Subtract case pressure from system pressure to compute the actual setting.

8.1 Pressure Compensator (PC) Control Adjustments (continued)

8.1.2 74 cc Frame Size

⚠ WARNING

Do not make adjustments or disconnect any hoses until all residual pressure in the system circuit has been released.

Take necessary precautions to secure the work function of the machine to prevent injury while performing this procedure.

Install a pressure gauge in port M2 to measure system pressure. Install a pressure gauge in case drain port L1 or L2 to measure case pressure. *Refer to Pressure Measurement, page 14.*

Loosen the PC set screw and turn the adjustment screw counter clockwise to release the spring pressure. Turn until the end of the screw is flush with the housing.

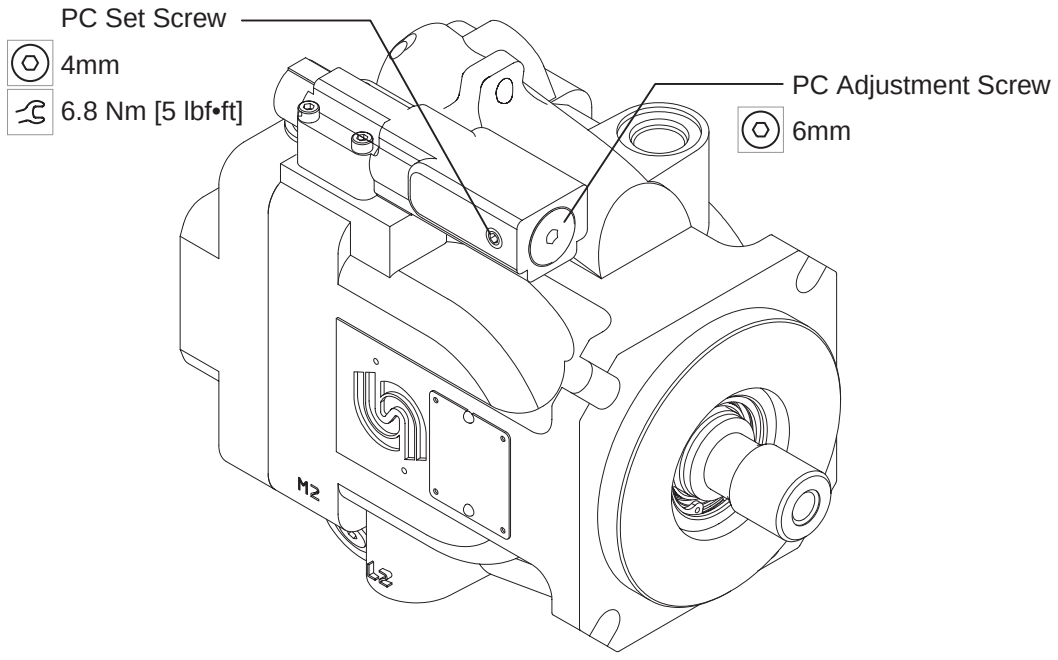
Start the prime mover and allow fluid to reach normal operating temperature.

Operate the prime mover at normal speed. Operate a hydraulic function to its full extension, loading the pump at maximum pressure and zero flow.

Turn the PC adjustment screw until system pressure reaches the desired value, as indicated on the gauge at port M2[1]. Clockwise rotation will increase the setting, counterclockwise rotation will decrease. If the pressure does not increase, an external system relief valve may need adjustment. External system relief valve should be set above the PC setting for proper operation.

While holding the position of the PC adjustment screw, torque the setscrew to 6.8 Nm [5 lbf•ft].

Stop the prime mover and remove the pressure gauges installed at port M2, and case drain port L1 or L2. Replace the port plugs.



P101 053E

1. PC setting is referenced to case pressure. Subtract case pressure from system pressure to compute the actual setting.

8.2 Load Sensing (LS or LB) Control Adjustment

8.2.1 57 cc Frame Size

⚠ WARNING

Do not make adjustments or disconnect any hoses until all residual pressure in the system circuit has been released.

Take necessary precautions to secure the work function of the machine to prevent injury while performing this procedure.

The LS or LB Setting is indicated in the pump model code. *Refer to the Technical Information Manual BLN-10128 for more information.*

Install a pressure gauge in port M2 to measure system pressure. Install a pressure gauge in drain port L1 or L2 to measure case pressure. Install a pressure gauge in the remote PC port. If remote PC is used, temporarily remove the remote PC signal line and cap it. **Leave the LS signal line connected**. *Refer to Pressure Measurement, page 14.*

Start the prime mover and allow fluid to reach normal operating temperature.

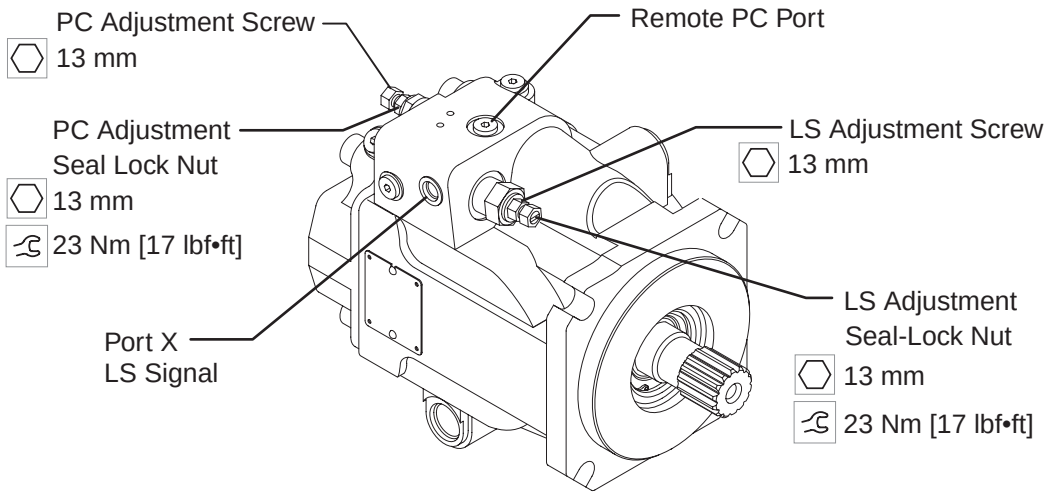
While securing the LS adjustment screw, loosen the seal locknut. Slowly operate a hydraulic function which will demand approximately half flow from the pump, but keep the system pressure below the PC set point. While watching the pressure gauges, turn the LS adjustment screw[1] until the desired pressure differential between port M2 (system pressure) and the remote PC port (LS signal) is achieved[2]. Clockwise rotation will increase the setting, counterclockwise rotation will decrease.

While holding the position of the adjustment screw, torque the seal locknut to 23 Nm [27 lbf•ft].

Operate a hydraulic function to its full extension loading the pump at maximum pressure and zero flow. While securing the PC adjustment screw, loosen the seal locknut. Turn the PC adjustment screw[1] until the desired setting is indicated on the pressure gauge at port M2[3]. Clockwise rotation will increase the setting, counterclockwise rotation will decrease. If the pressure does not increase, an external system relief valve may need to be adjusted. External system relief valve should be set above the PC setting for proper operation.

While holding the position of the PC adjustment screw, torque the seal locknut to 23 Nm [17 lbf•ft].

Stop the prime mover, remove the pressure gauges, and return the system to its normal operating configuration.



P101 048E

1. Pumps with serial number greater than A-98-21-XXXX will have tamper resistant hardware installed on both the PC and second stage adjustments. This will only allow one complete clockwise turn from the original factory setting.

2. The LS setting is a differential pressure. Subtract pilot pressure at the remote PC port from system pressure at port M2 to compute the actual setting.

3. PC setting is referenced to case pressure. Subtract case pressure from system pressure to compute the actual setting.

8.2 Load Sensing (LS or LB) Control Adjustment (continued)

8.2.2 74 cc Frame Size

⚠ WARNING

Do not make adjustments or disconnect any hoses until all residual pressure in the system circuit has been released.

Take necessary precautions to secure the work function of the machine to prevent injury while performing this procedure.

The LS or LB Setting is indicated in the pump model code. *Refer to the Technical Information Manual, BLN-10128 for more information.*

Install a pressure gauge in port M2 to measure system pressure. Install a pressure gauge in drain port L1 or L2 to measure case pressure. Install a pressure gauge in port X to measure LS signal pressure. **Leave the LS signal line connected, using the opposite port for the gauge.** *Refer to Pressure Measurement, page 14.*

Start the prime mover and allow fluid to reach normal operating temperature.

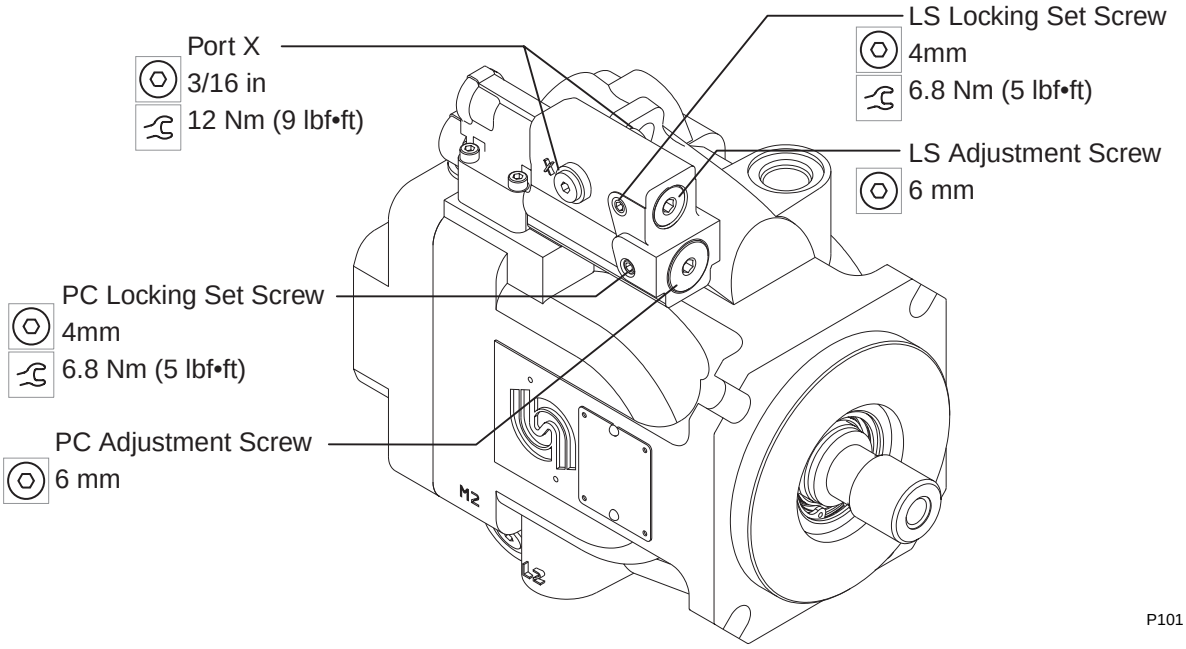
Loosen the LS locking set screw. Slowly operate a hydraulic function which will demand approximately half flow from the pump, but keep the system pressure below the PC set point. While watching the pressure gauges, turn the LS adjustment screw until the desired pressure differential between port M2 (system pressure) and port X (LS signal) is achieved[1]. Clockwise rotation will increase the setting, counterclockwise rotation will decrease.

While holding the position of the adjustment screw, torque the locking set screw to 6.8 Nm [5 lbf•ft].

Operate a hydraulic function to its full extension loading the pump at maximum pressure and zero flow. While securing the PC adjustment screw, loosen the seal locknut. Turn the PC adjustment screw until the desired setting is indicated on the pressure gauge at port M2[2]. Clockwise rotation will increase the setting, counterclockwise rotation will decrease. If the pressure does not increase, an external system relief valve may need to be adjusted. External system relief valve should be set above the PC setting for proper operation.

While holding the position of the PC adjustment screw, torque the locking set screw to 6.8 Nm [5 lbf•ft].

Stop the prime mover, remove the pressure gauges, and return the system to its normal operating configuration.



P101 049E

1. The LS setting is a differential pressure. Subtract pilot pressure at port X from system pressure at port M2 to compute the actual setting.

2. PC setting is referenced to case pressure. Subtract case pressure from system pressure to compute the actual setting.

8.3 Displacement Limiter Adjustment

If equipped, the displacement limiter may be adjusted to achieve a desired maximum flow rate.

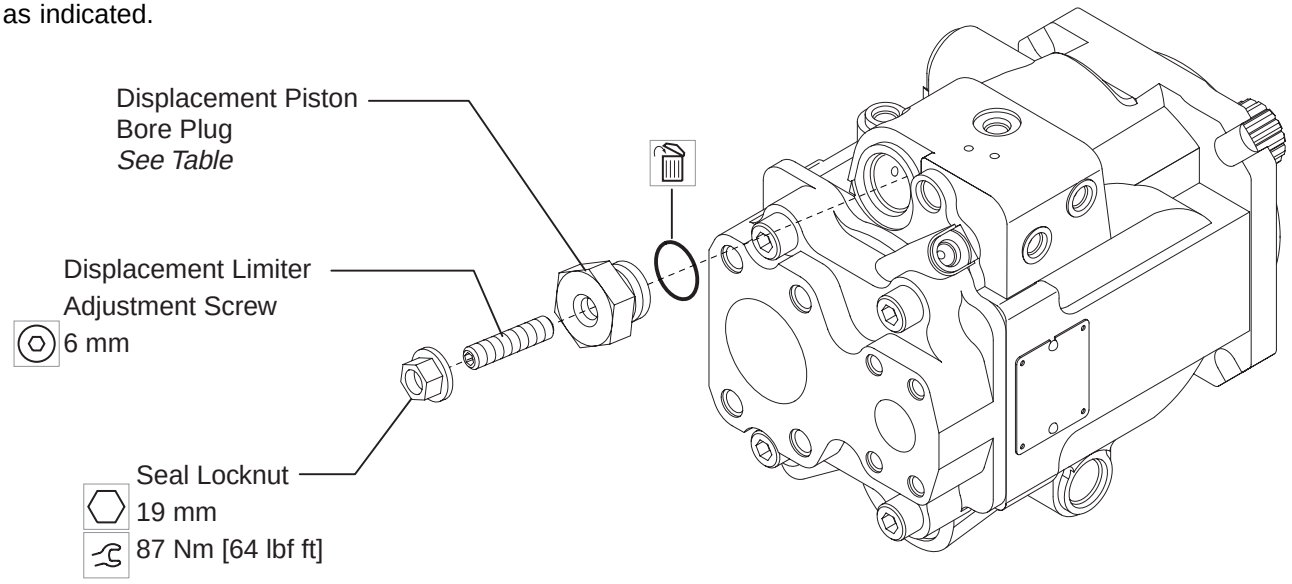
The preferred method for setting the displacement limiter is to make adjustments while operating the pump at full stroke on an appropriate test apparatus equipped with a flow meter and system pressure gauge. This allows the pump to be set to a specific maximum flow rate under precise speed and pressure conditions. If test apparatus is not available, the following procedure may be used to set an approximate maximum displacement. Remember to verify that the displacement setting is appropriate by operating the pump in its application after adjustment.

To adjust the displacement limiter setting remove the displacement piston bore plug with its o-ring. Loosen the seal locknut and turn the displacement limiter adjustment screw counter clockwise until the opposite end is flush with end of the displacement piston bore plug. The setting is now at maximum displacement. Replace the o-ring and install the plug into the pump housing. Torque the displacement piston plug as indicated.

Turn the displacement limiter adjustment screw clockwise to set the desired maximum displacement. For 57cc pumps, the displacement is decreased by 5cc per revolution of the displacement limiter adjustment screw; for 74cc pumps, 6cc per revolution.

While holding the position of the displacement limiter adjustment screw, torque the seal locknut.

⚠ WARNING
The seal lock nut must be torqued after every adjustment to prevent an unexpected change in pump output and to prevent external leakage during unit operation.



(57 CC Shown)

P101 106E

Displacement Piston Bore Plug		
	57 cc	74 cc
Hex Wrench	1 1/4 in	1 3/8 in
Torque	230 Nm [170 lbf•ft]	176-244 [130-180lbf•ft]

T101 003E

Notes:

9. Minor Repair Instructions

9.1 Shaft Seal Replacement

A lip type shaft seal is used in the Series 45 open circuit variable pumps. This seal can be replaced without major disassembly of the unit.

Replacement of the shaft seal requires removal of the pump from the machine.

Remove the retaining ring (item K010) from the housing.

After removing the retaining ring, carefully remove the shaft seal (item K020) from the bore in the pump housing. The face of the seal may be punctured with a sharp instrument to aid in prying the seal out, or a slide hammer type puller may be used to remove the seal. Care must be taken to avoid damaging the pump housing or shaft. Discard the shaft seal.

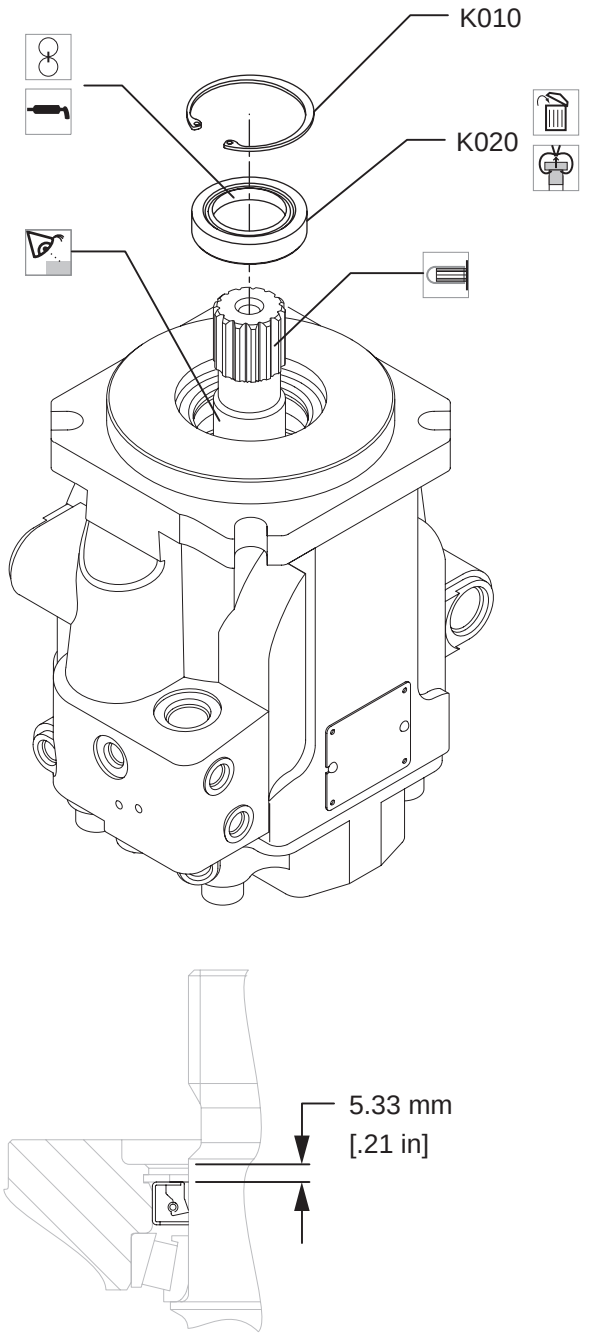
Inspect the pump housing and the new seal for damage. Inspect the sealing area on the shaft for rust, wear, or contamination. Polish the sealing area on the shaft if necessary.

Use a seal protection sleeve or wrap the end of shaft with thin plastic to prevent damage to the seal lip during installation. Lubricate the inside diameter of the new seal with petroleum jelly.

Press the new seal into the housing just far enough to clear the retaining ring groove. Keep the shaft seal perpendicular to the shaft. The cupped side of the shaft seal must face the shaft bearing. Do not damage the seal during installation.

CAUTION
Do not press the seal into the housing farther than necessary to install the retaining ring. The seal must not contact the shaft bearing.

Using the appropriate snap ring pliers, install the seal retaining ring.



P101 051

9.2 Displacement Piston and Maximum Displacement Limiter

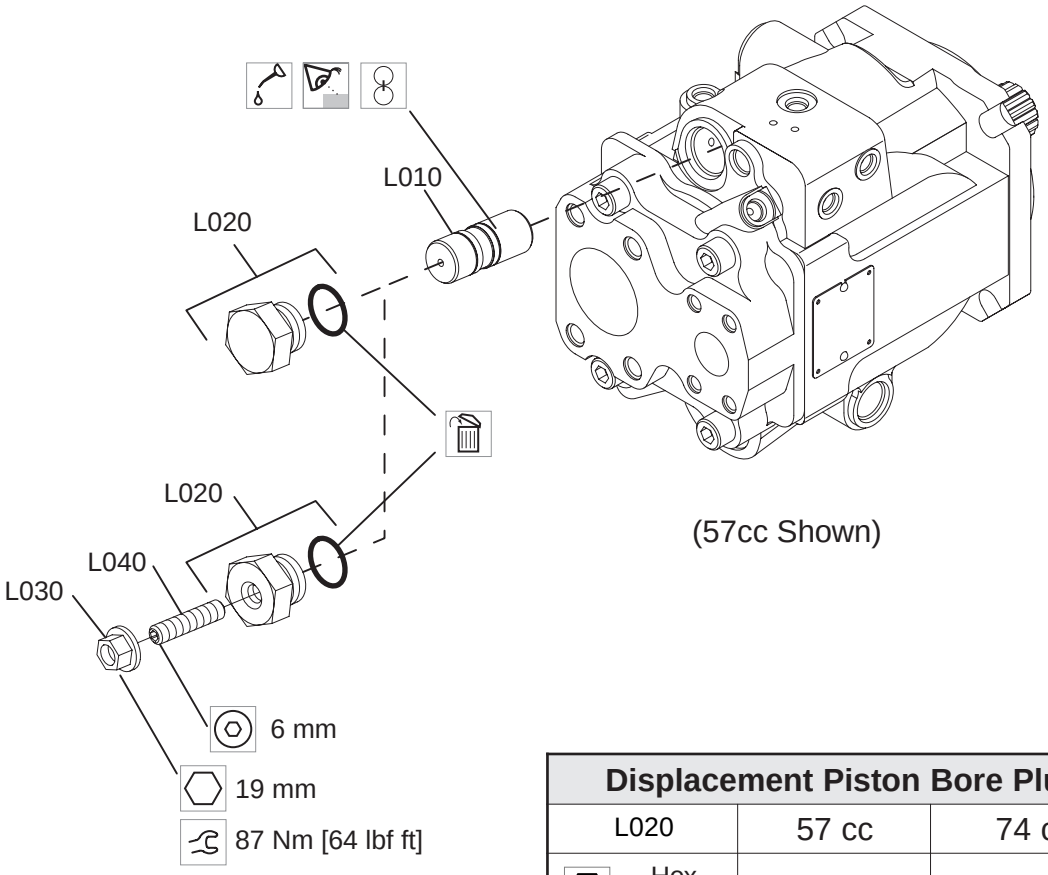
Remove the displacement piston bore plug (item L020) with its o-ring. Discard the o-ring. Remove the displacement piston (item L010) from the pump housing. If equipped with displacement limiter, loosen the seal lock nut (item L030), remove the nut and limiter screw (item L040) from the displacement piston bore plug (item L020).

Inspect the displacement piston for wear or damage.

Lubricate the displacement control piston with hydraulic oil and install it into the pump housing with the hole in the end of the piston facing the bore plug.

Install a new o-ring on the piston bore plug and, if equipped, install the displacement limiter screw and seal locknut. Adjust the displacement limiter. *See Adjustments, page 26.* Install the piston bore plug into the pump housing. Torque the displacement piston plug as indicated.

⚠ WARNING
The seal lock nut must be torqued after every adjustment to prevent an unexpected change in pump output and to prevent external leakage during unit operation.



(57cc Shown)

P101 052E

Displacement Piston Bore Plug		
L020	57 cc	74 cc
Hex Wrench	1 1/4 in	1 3/8 in
Torque	230 Nm [170 lbf•ft]	176-244 [130-180lbf•ft]

T101 003E

9.3 Bias Piston

Remove the bias piston guide (item B081) (with the bias spring, bias piston, o-rings and backup washer) from the pump housing. Remove the bias spring (item B083) and bias piston (item B084) from the piston guide.

Remove the backup washer (item K110), small o-ring (item K100), and large o-ring (item B082) from the piston guide.

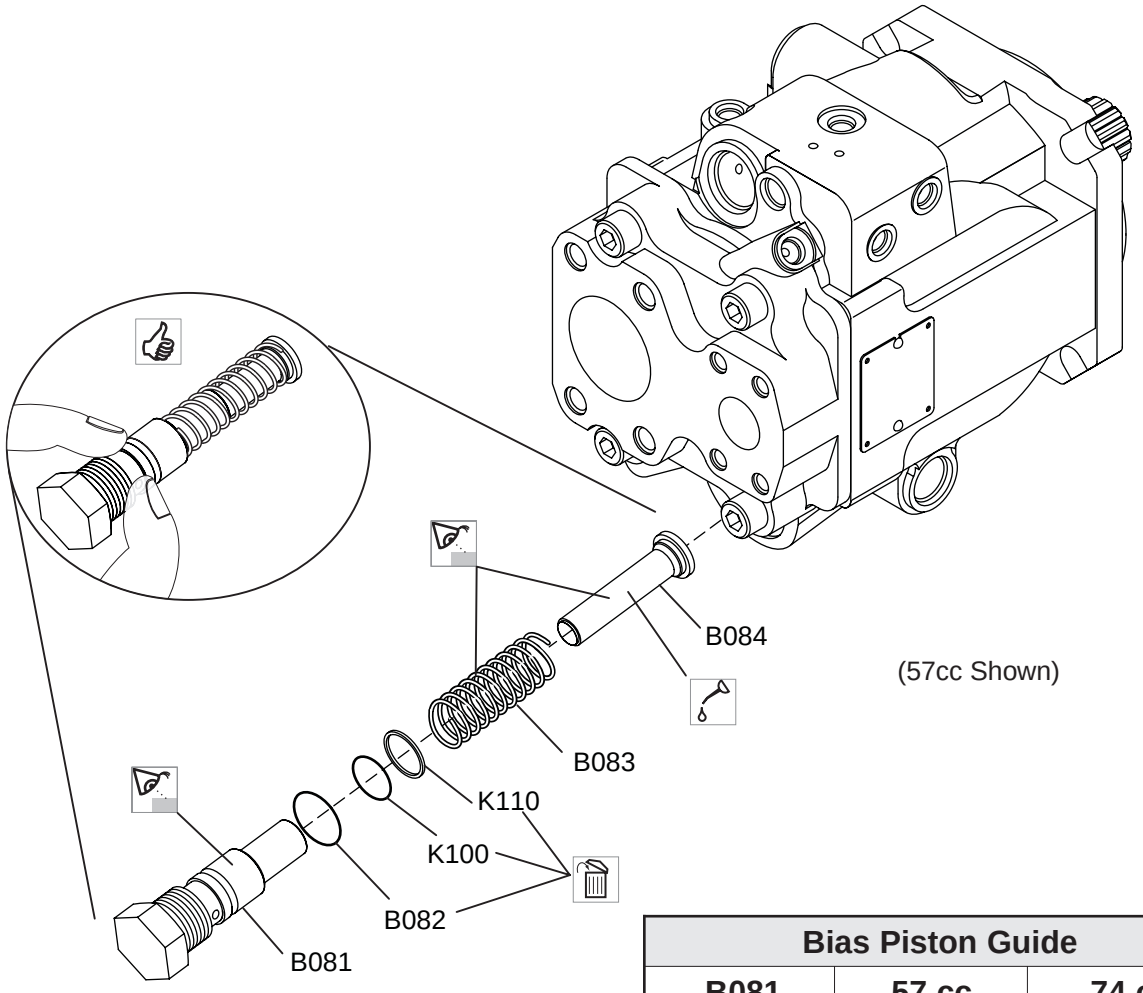
Inspect the bias piston, piston guide, and spring for wear or damage.

Install new o-rings and a new backup washer on the piston guide. Install the bias spring on the piston guide. Lubricate the bias piston with hydraulic oil and install it onto the piston guide.

Install the piston guide assembly into the pump housing and torque as indicated.

TIP

To keep the bias piston in position during assembly, hold a finger over the hole in the bias piston guide when installing.



P101 054E

Bias Piston Guide		
B081	**57 cc**	**74 cc**
Hex Wrench	1 1/4 in	1 3/8 in
Torque	230 Nm [170 lbf•ft]	176-244 [130-180 lbf•ft]

T101 003E

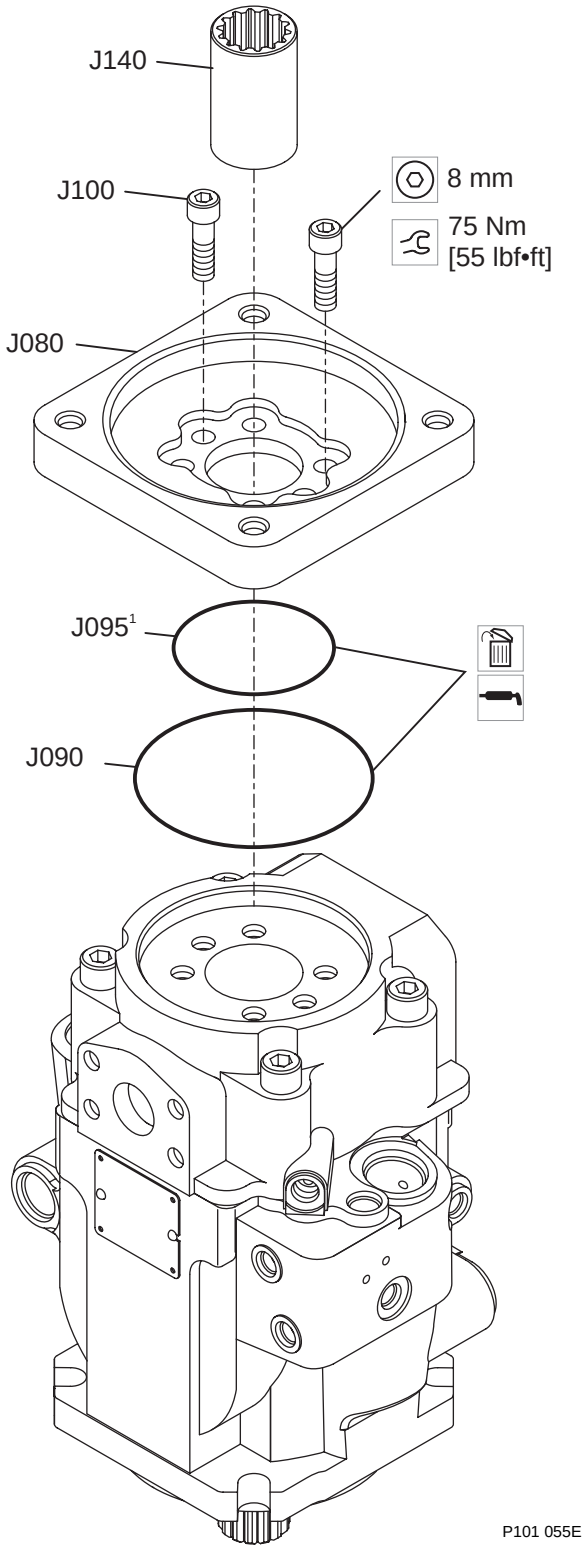
9.4 Auxiliary Pads

If installed, remove the screws retaining the auxiliary pump (not shown), and remove the pump with its sealing o-ring. Discard the o-ring. Remove the drive coupling (item J140).

Remove the four screws (item J100) retaining the pad adapter (item J080) to the pump end cap (six screws are used for the SAE C pad). Discard the two pad adapter o-rings (items J090, J095).

Install the pad adapter with new o-rings[1]. Lubricate o-rings with petroleum jelly before installation. Install and torque the screws to 75 Nm [55 lbf•ft].

Install the drive coupling. If equipped, install the auxiliary pump with new o-ring.



1. Units with serial number prior to A97-42-XXXX do not use item J095.

9.5 Control Personality Conversion, 57cc Only

On the 57cc pump, control personalities may be easily converted between load sensing (LS) and pressure compensating (PC) options. The conversion steps required are listed below.

Refer to Minor Repair, page 35, for instructions on removal and replacement of parts referenced in this procedure.

After conversion, check setting and adjust as necessary. *See Adjustments, pages 22 and 24.*

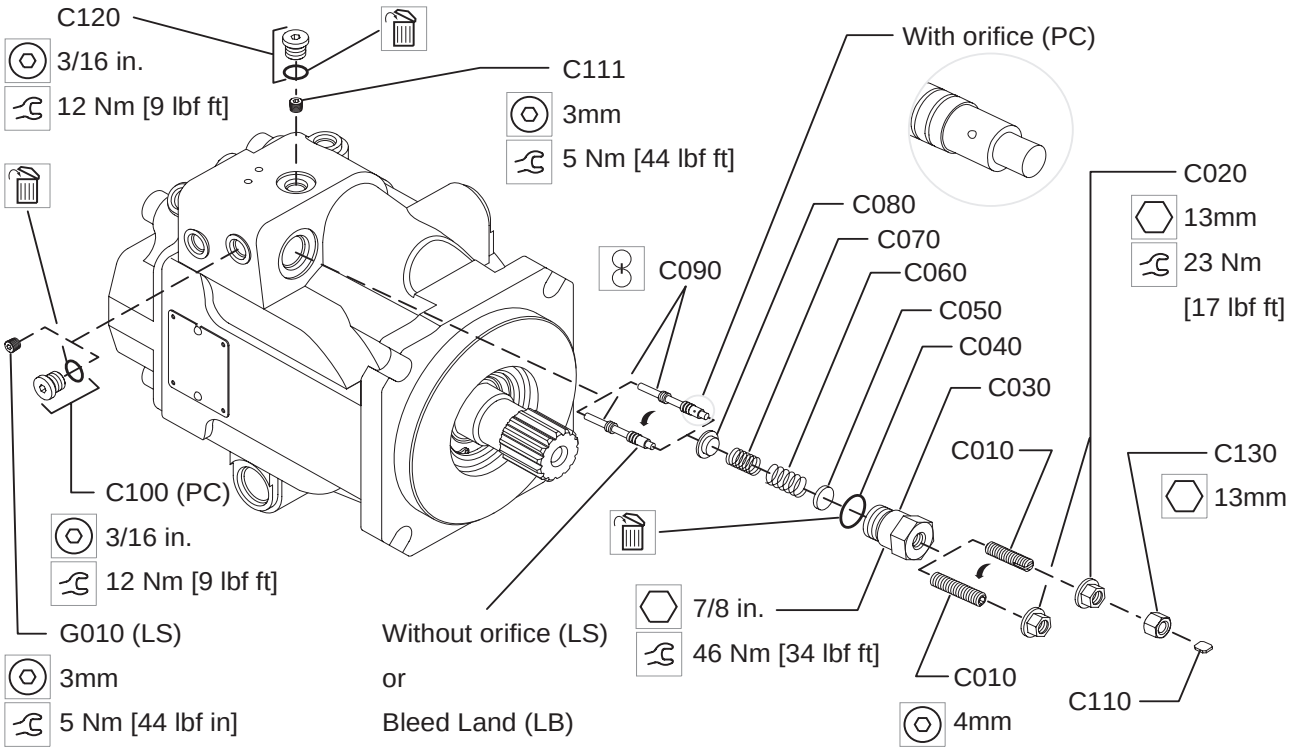
To convert from **PC** to **LS** control option:

1. Remove PC spool (C090) (orificed spool).
2. Install LS spool (C090) (non-orificed spool).
3. Add pilot orifice (G010).
   (Size varies from .8mm to 1.1 mm)

   Refer to Service Parts Manual, BLN-2-41689, for orifice part numbers.

To convert from **LS** to **PC** control option:

1. Remove LS spool (C090) (non-orificed spool)
2. Install PC spool (C090) (orificed spool)
3. Remove pilot orifice (G010)



P101 057E

9.6 Pressure Compensator (PC) Control Pilot Stage and Gain Orifice

9.6.1 57 cc Frame Size

Remove the PC valve cartridge assembly (with o-rings and backup washer) from the pump housing.

Remove and discard the small o-ring (item K080), backup washer (item K090), and large o-ring (item D016) found on the cartridge assembly.

Loosen the seal lock nut (item D015) and remove the adjustment screw[1] (item D014), spring (item D013), and poppet (item D012) from the cartridge housing (item D011).

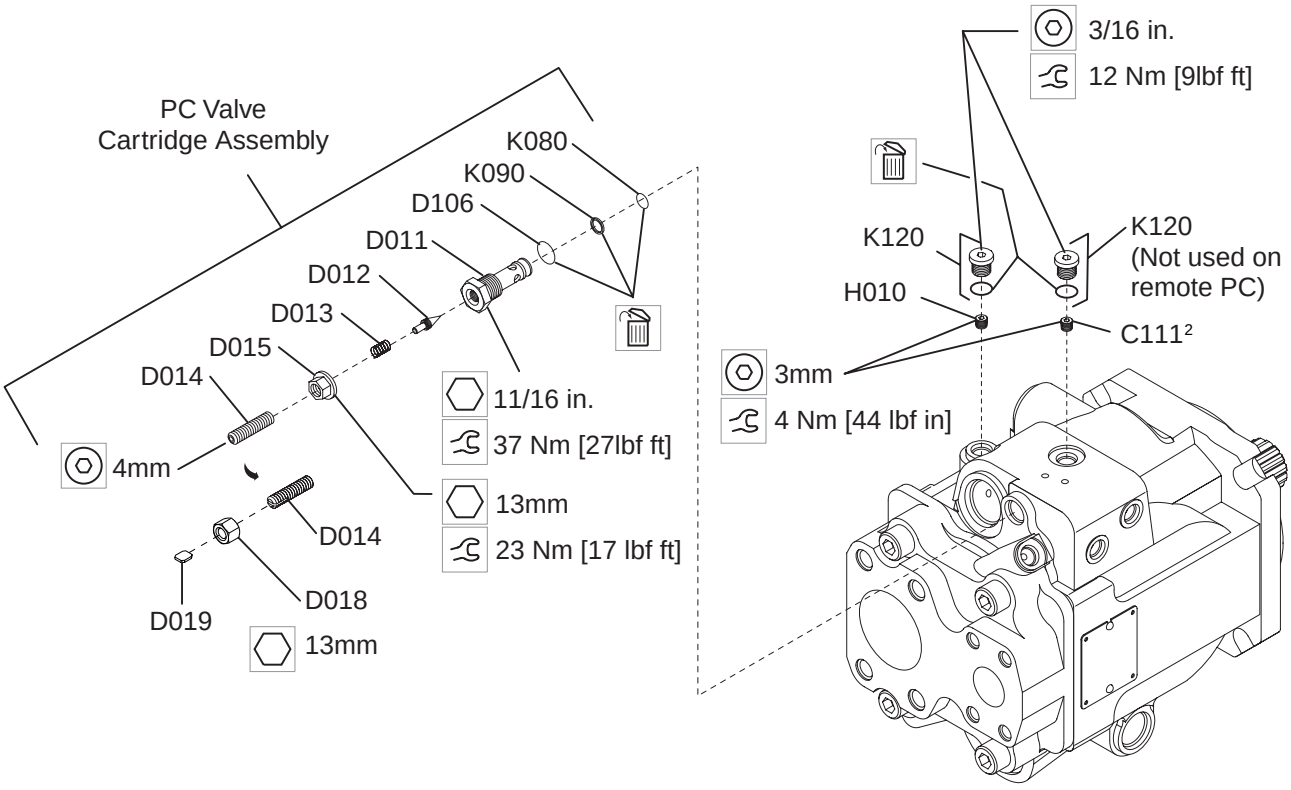
Inspect all parts for wear or damage.

Install new o-rings and a new backup washer on the cartridge housing. Install the poppet, spring, and adjustment screw (with seal lock nut) into the cartridge housing.

Install the cartridge assembly into the pump housing and torque to 37 Nm [27 lbf•ft].

Check and adjust the pressure compensator setting before putting the pump back into operation. *See Adjustments, page 22.*

The control gain orifice plug (item H010) and bleed orifice plug[2] (item C111) may be removed after removing the passage plugs (items K120) in the pump housing. Inspect orifice plugs for blockage, clean as necessary and reassemble. Torque orifice plugs to 5 Nm [44 lbf•in], passage plugs to 12 Nm [9 lbf•ft].



P101 058E

1. Pumps with serial number greater than A-98-21-XXXX will have tamper resistant hardware (items D018 and D019) installed on the PC adjustment screw. This will only allow one complete clockwise turn from the original factory setting.

2. Pumps with serial number greater than A-97-52-XXXX do not use bleed orifice (item C111). The port in the housing is also blocked.

9.6 Pressure Compensator (PC) Control Pilot Stage and Gain Orifice (continued)

9.6.2 74 cc Frame Size

Remove the set screw (item C102) and the PC adjustment screw (item C138). The control springs (items C134 and C135) and spring seat (item C133) can now be removed from the cavity.

Remove the plug (item C103) from the opposite end of the control and remove the control spool (item C132). Note the orientation of the control spool for reassembly.

Remove the four control mounting screws (item C300). Remove the control and interface o-rings (items C200) from the housing.

Remove the control gain orifice (item H010).

Flush the control cavity and wash all parts with clean solvent. Air dry.

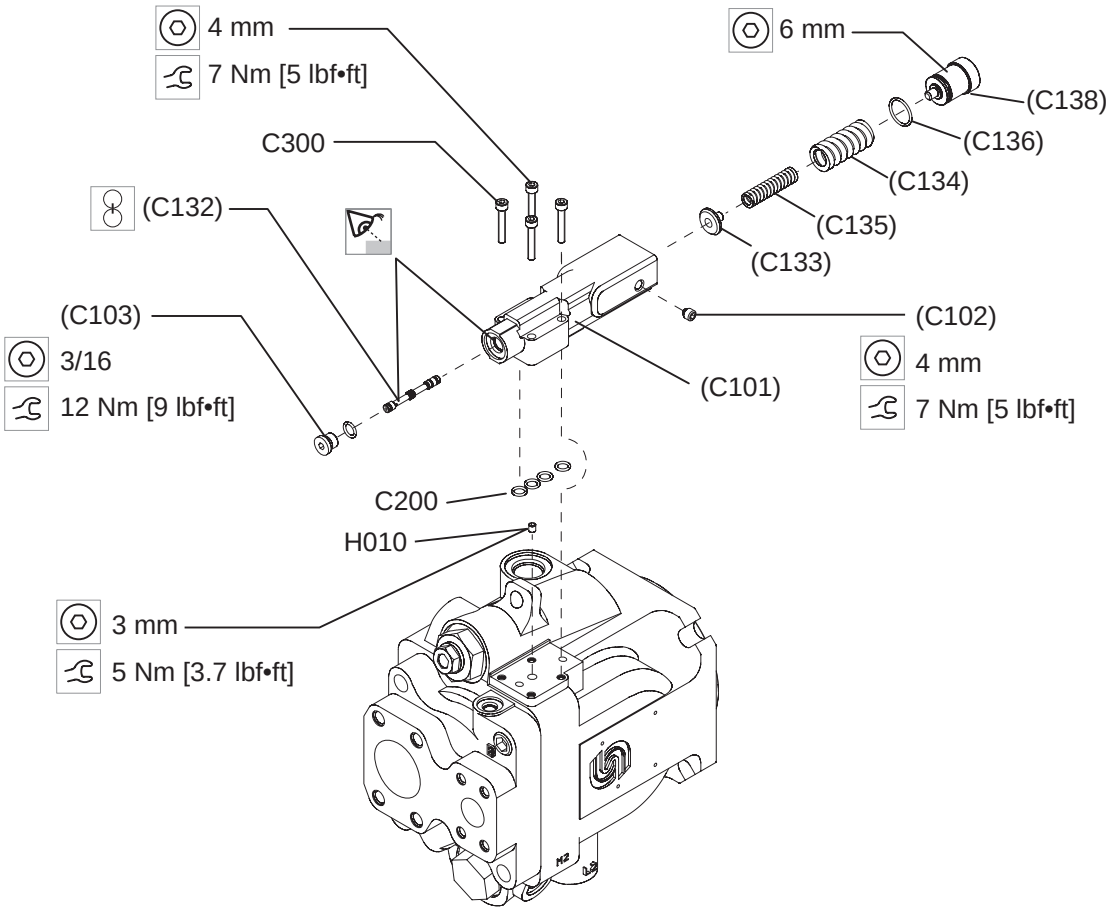
Inspect spool, cavity surfaces, and all parts for wear or damage. Remove any contamination from gain orifice. Replace damaged or worn parts as necessary.

Install gain orifice, torque to 5 Nm [3.7 lbf•ft].

Install control on pump housing, replacing all o-rings. Install mounting screws, torque to 7 Nm [5 lbf•ft].

Install control springs and spring seat in cavity. Install adjustment screw and set screw, torque set screw to 7 Nm [5 lbf•ft]. Install control spool and plug, torque to 12 Nm [9 lbf•ft]. Verify orientation of spool before installation.

Check PC setting and adjust as necessary. *See Adjustments, page 23*.



P101 056E

9.7 Load Sensing (LS or LB) Control or Pressure Compensator (PC) Second Stage

9.7.1 57 cc Frame Size

Remove the cavity plug assembly (Items C030, C010, C020, C130, and C110) from the pump housing. Remove and discard the o-ring (item C040) from the cavity plug (item C030).

If necessary, remove the seal lock nut (item C020) and adjustment screw[1] (item C010) from the cavity plug.

Remove the outer spring seat (item C050) from the cavity.

Remove the outer spool spring (item C060) and the inner spool spring (item C070).

Remove the inner spring seat (item C080) and the control spool (item C090). Note the orientation of the control spool for reassembly.

If used, remove the load sensing pilot orifice (item G010) and bleed orifice[1] (item C111). Check for contamination and reinstall, torque to 5 Nm [44 lbf•in].

Clean and inspect all parts for wear or damage. Check the orifice in the PC second stage spool for obstruction.

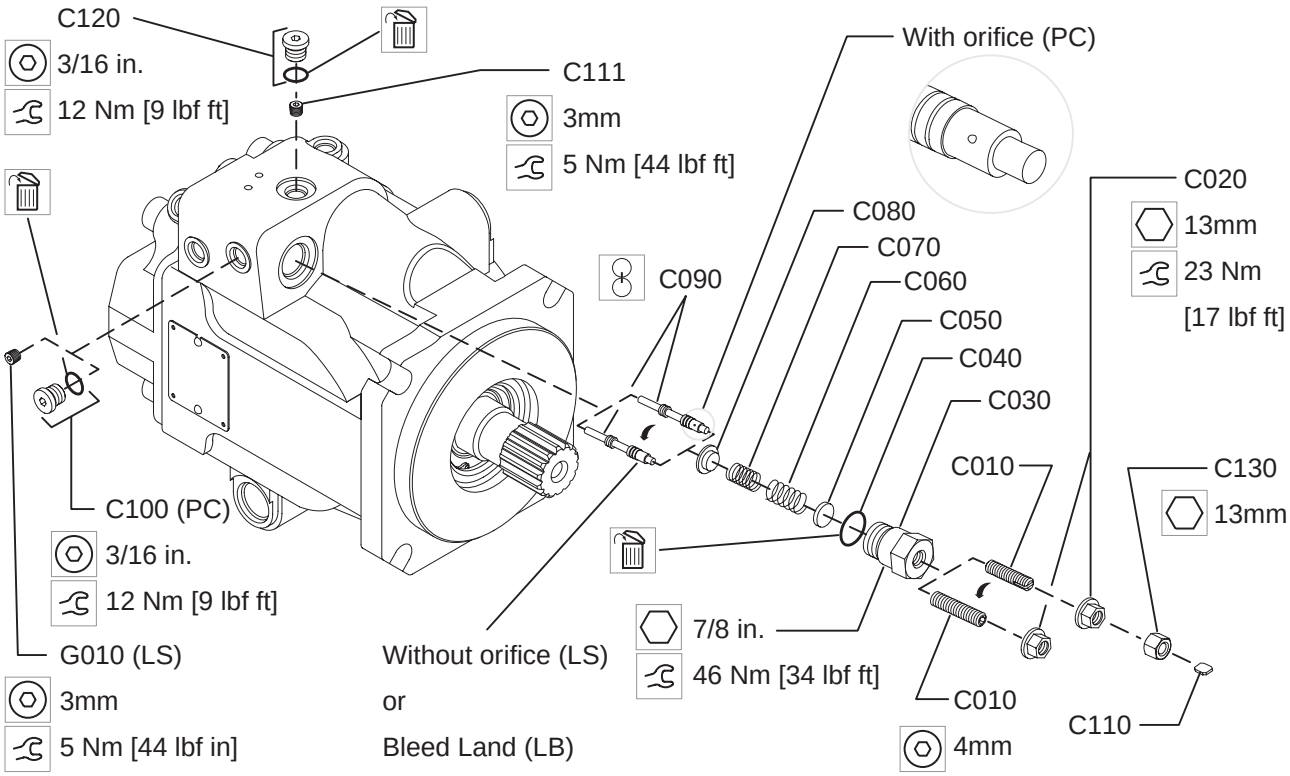
Install the control spool to the cavity, insure proper orientation. Install the inner spring seat onto the end of the control spool. If the spool is not properly oriented, the inner spring seat will not fit.

Install the inner and outer spool springs.

If removed, install the adjustment screw and seal lock nut to the cavity plug. Hand tighten the seal locknut, it must be torqued after adjustment.

Install a new o-ring onto the cavity plug. Place the outer spring seat in the plug. Install the plug into the cavity and torque to 46 Nm [34 lbf•ft].

Follow the appropriate adjustment procedure before returning the pump to full operation. *See adjustments, page 22.*



1. Pumps with serial number greater than A-98-21-XXXX will have tamper resistant hardware (items D018 and D019) installed on the PC adjustment screw. This will only allow one complete clockwise turn from the original factory setting.

2. Pumps with serial number greater than A-97-52-XXXX do not use bleed orifice (item C111). Bleed orifice is incorporated into the control spool (item C090). The port in the housing is also blocked.

9.7 Load Sensing (LS or LB) Control or Pressure Compensator (PC) Second Stage (continued)

9.7.2 74 cc Frame Size

Loosen the two set screws (items C102). Remove the PC adjustment screw (item C138) and o-ring (item C136); discard o-ring. Remove control springs (items C134, C135) and spring seat (item C133) from the cavity.

Remove the LS adjustment screw (item C118), o-ring (item C116), and back-up rings (items C117); discard o-ring and back-up rings. Remove control springs (item C114 and C115) and spring seat (item C113) from the cavity.

Remove the plugs (item C103) from the opposite end of the control housing and remove the control spools (item C132 and C112). Note orientation for reassembly.

Remove the four socket head screws (item C300) which hold the control to the housing.

Remove the control from the housing. Remove the interface o-rings (item C200) and discard. Remove the control gain orifice (item H010).

Clean all parts in solvent. Air dry. Inspect spools, cavity surfaces, and all parts for wear or damage. Remove any contamination from gain orifice. Replace damaged or worn parts as necessary.

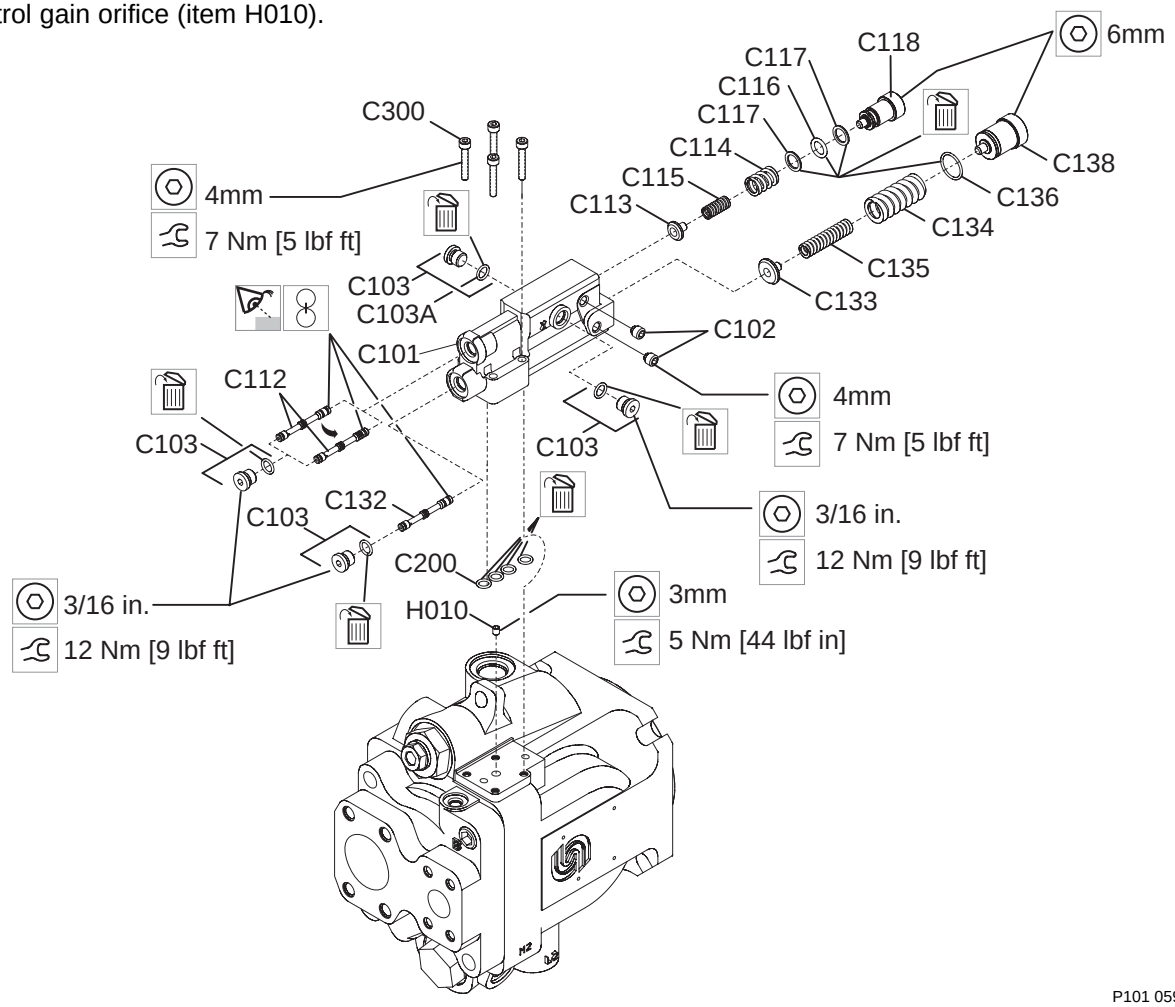
Install control housing on pump housing, replacing all o-rings; torque to 7 Nm [5 lbf•ft].

Install springs and spring seats in cavities. Replacing all o-rings and back-up rings, install both adjustment screws into to the control housing.

Install LS and PC set screws to control housing. After adjustment, torque to 7 Nm [5 lbf•ft].

Install control spools in opposite end of control housing, note proper orientation. Replace o-rings and install plugs; torque to 12 Nm [9 lbf•ft].

Check and adjust LS and PC settings before returning pump to operation. *See Adjustments, page 25.*

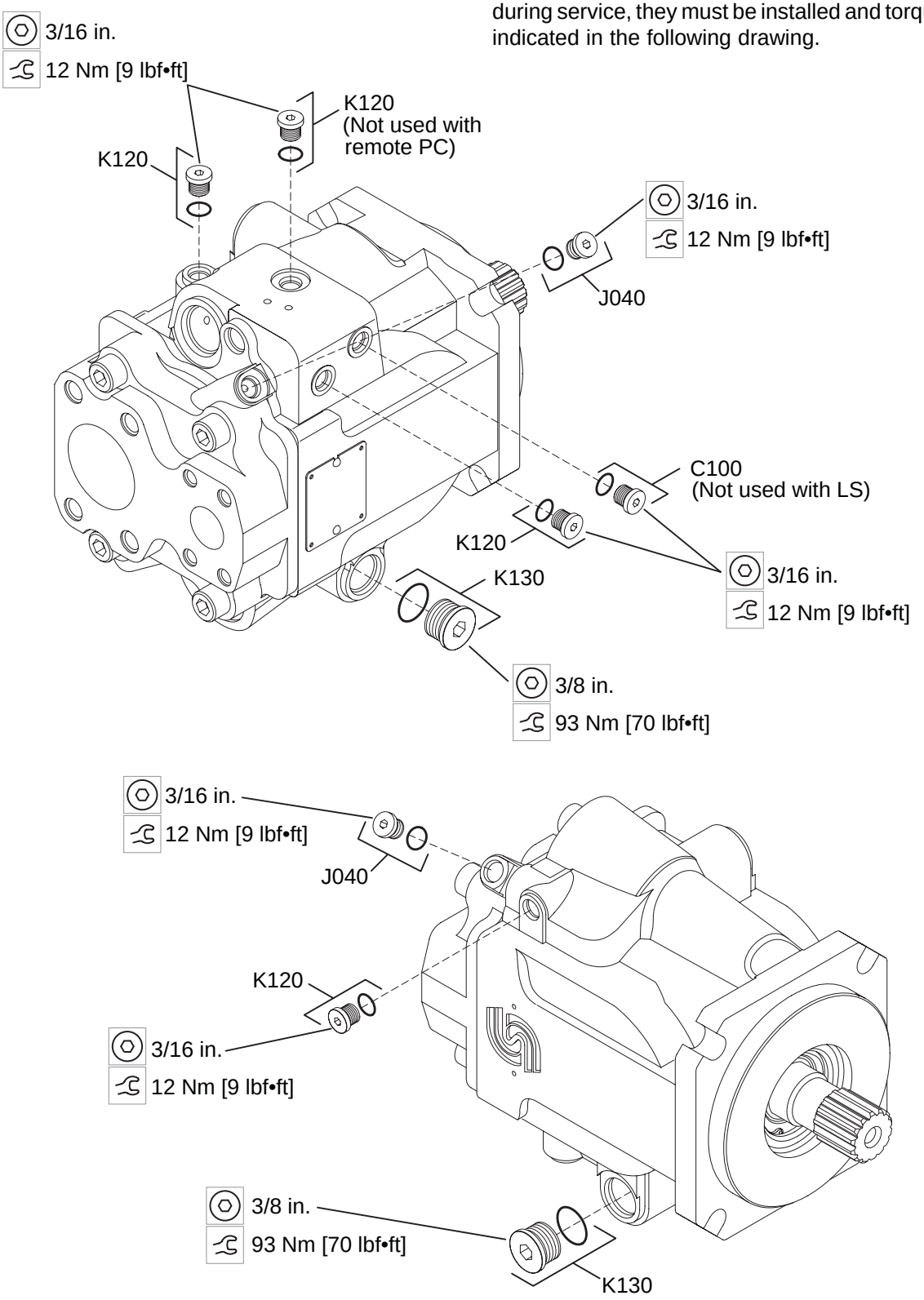


P101 059E

9.8 Plug and Fitting Torques

9.8.1 57 cc Frame Size

If any plugs or fittings are removed from the unit during service, they must be installed and torqued as indicated in the following drawing.

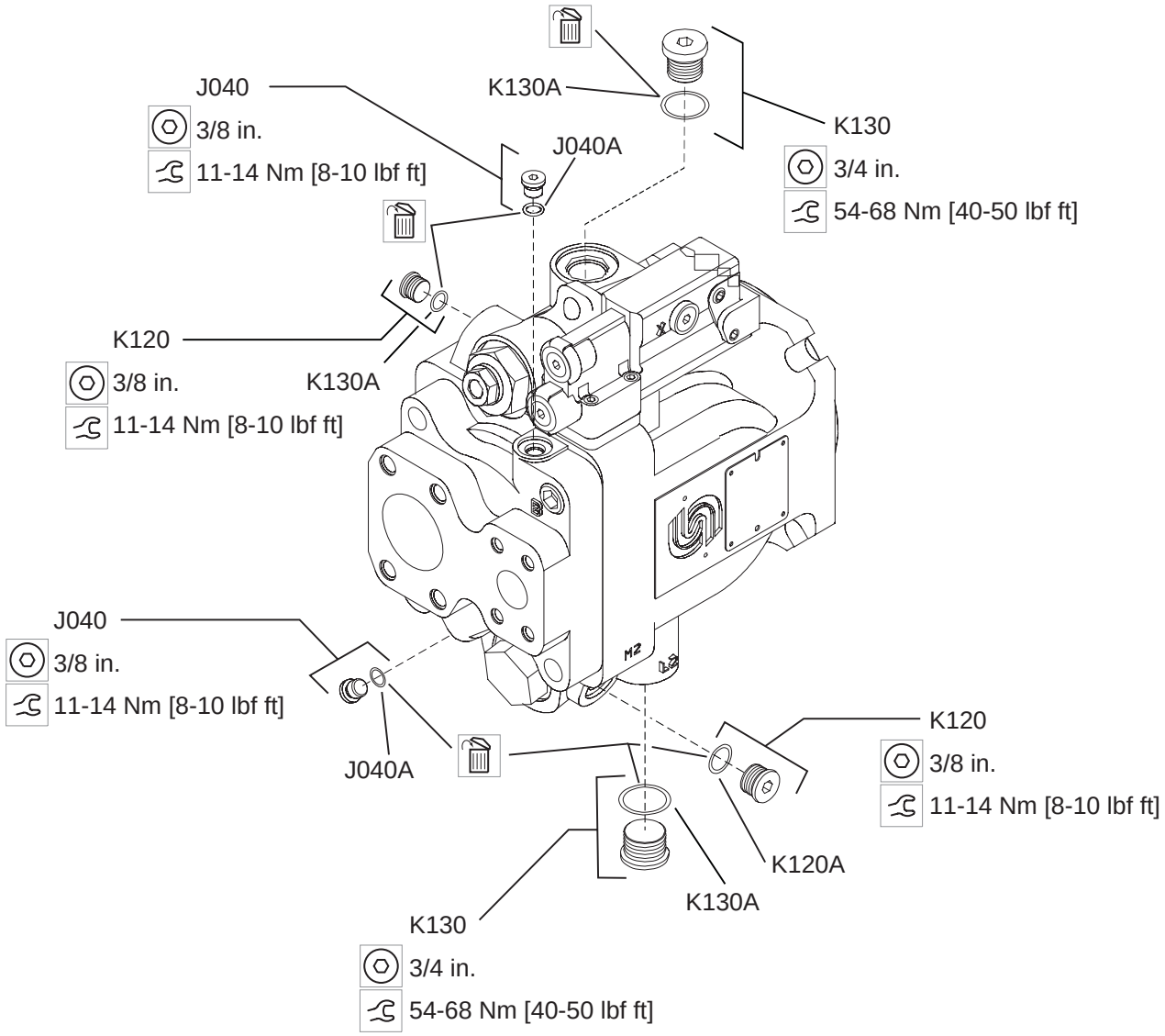


P101 060E

9.8 Plug and Fitting Torques (continued)

9.8.2 74 cc Frame Size

If any plugs or fittings are removed from the unit during service, they must be installed and torqued as indicated in the following drawing.

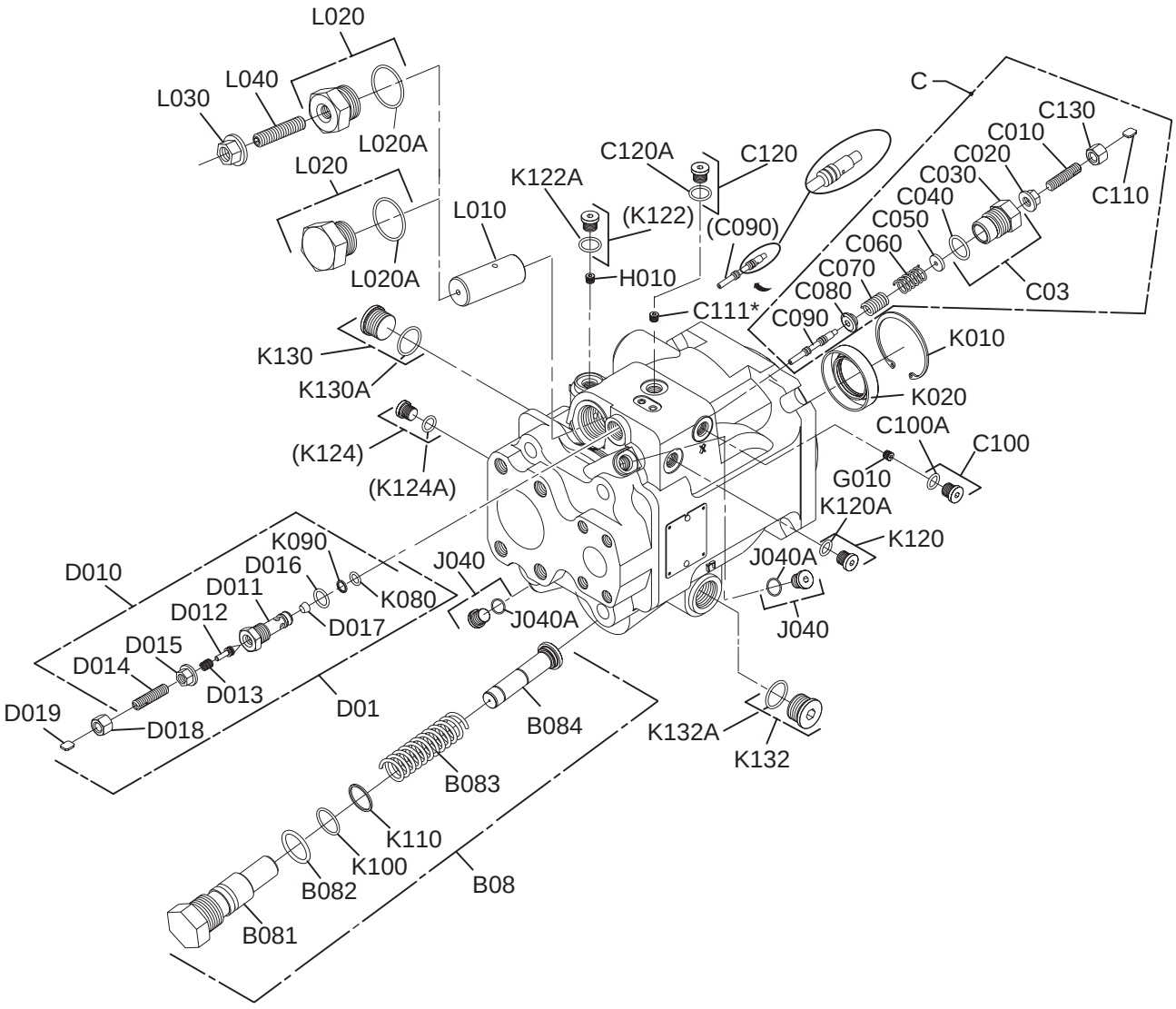


P101 061E

Notes:

10. Exploded Views

10.1 57 cc Frame Size



P101 062

10.1 57 cc Frame Size (continued)

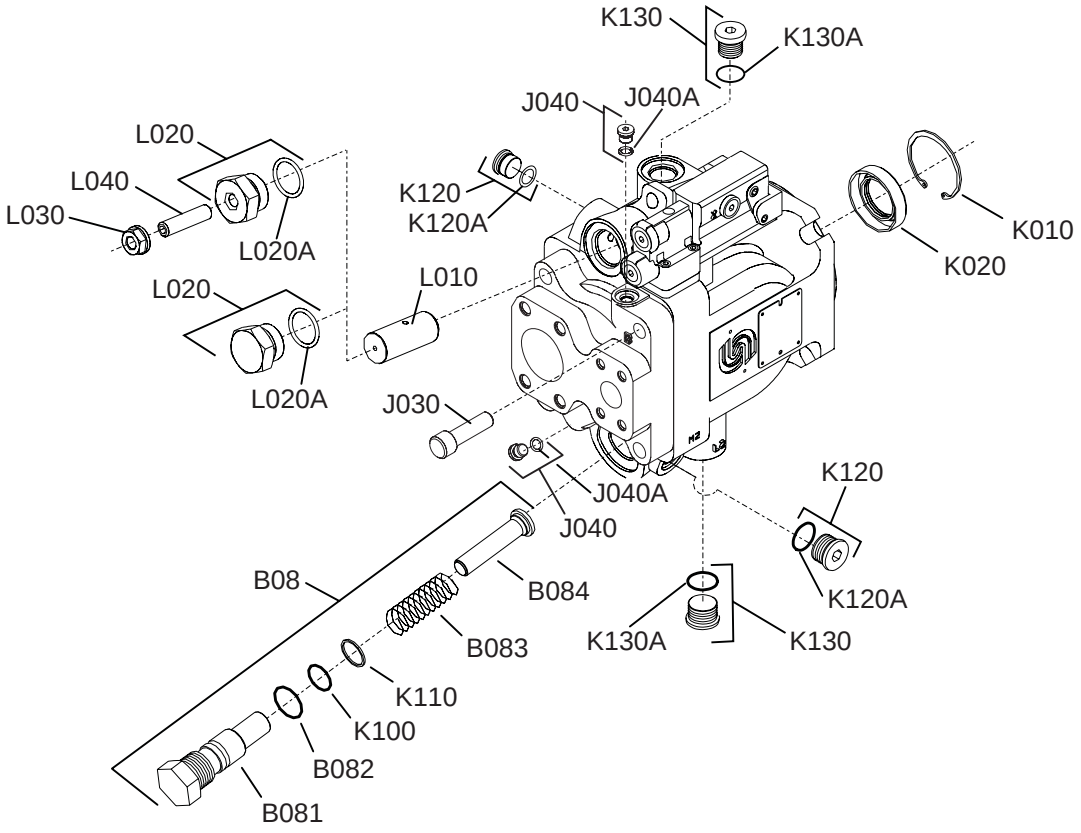
Parts List

Item	Description	Qty.
Control		
C010	Set screw	1
C020	Seal nut	1
C030	Plug	1
C040	O-ring	1
C050	Spring seat	1
C060	Spring	1
C070	Spring	1
C080	Spring guide	1
C090	Spool, LS or PC	1
C100	Plug	1
C100A	O-ring	1
C110	Wedge	1
C111*	Orifice plug	1
C120	Plug	1
C120A	O-ring	1
C130	Hex nut	1
Pressure Compensator Valve		
D011	Cartridge	1
D012	Poppet	1
D013	Spring	1
D014	Set screw	1
D015	Seal nut	1
D016	O-ring	1
D017	Screen	1
D018	Hex nut	1
D019	Set screw	1
K080	O-ring	1
K090	Back up ring	1
Pilot / Gain Orifice		
G010	Orifice	1
H010	Orifice	1
Displacement Limiter		
L010	Servo piston	1
L020	Plug	1
L020A	O-ring	1
L030	Seal nut	1
L040	Set screw	1

Item	Description	Qty.
Shaft Seal/Housing/Speed Sensing		
K010	Snap ring	1
K020	Lip seal	1
K100	O-ring	1
K110	Back up ring	1
K120	Plug	1
K120A	O-ring	1
K122	Plug	1
K122A	O-ring	1
K124	Plug	1
K124A	O-ring	1
K130	Plug	1
K130A	O-ring	1
K132	Plug	1
K132A	O-ring	1
Auxiliary		
J040	Plug	2
J040A	O-ring	2
Common Parts Group		
B081	Bias piston guide	1
B082	O-ring	1
B083	Spring	1
B084	Bias piston	1

* No longer used

10.2 74 cc Frame Size



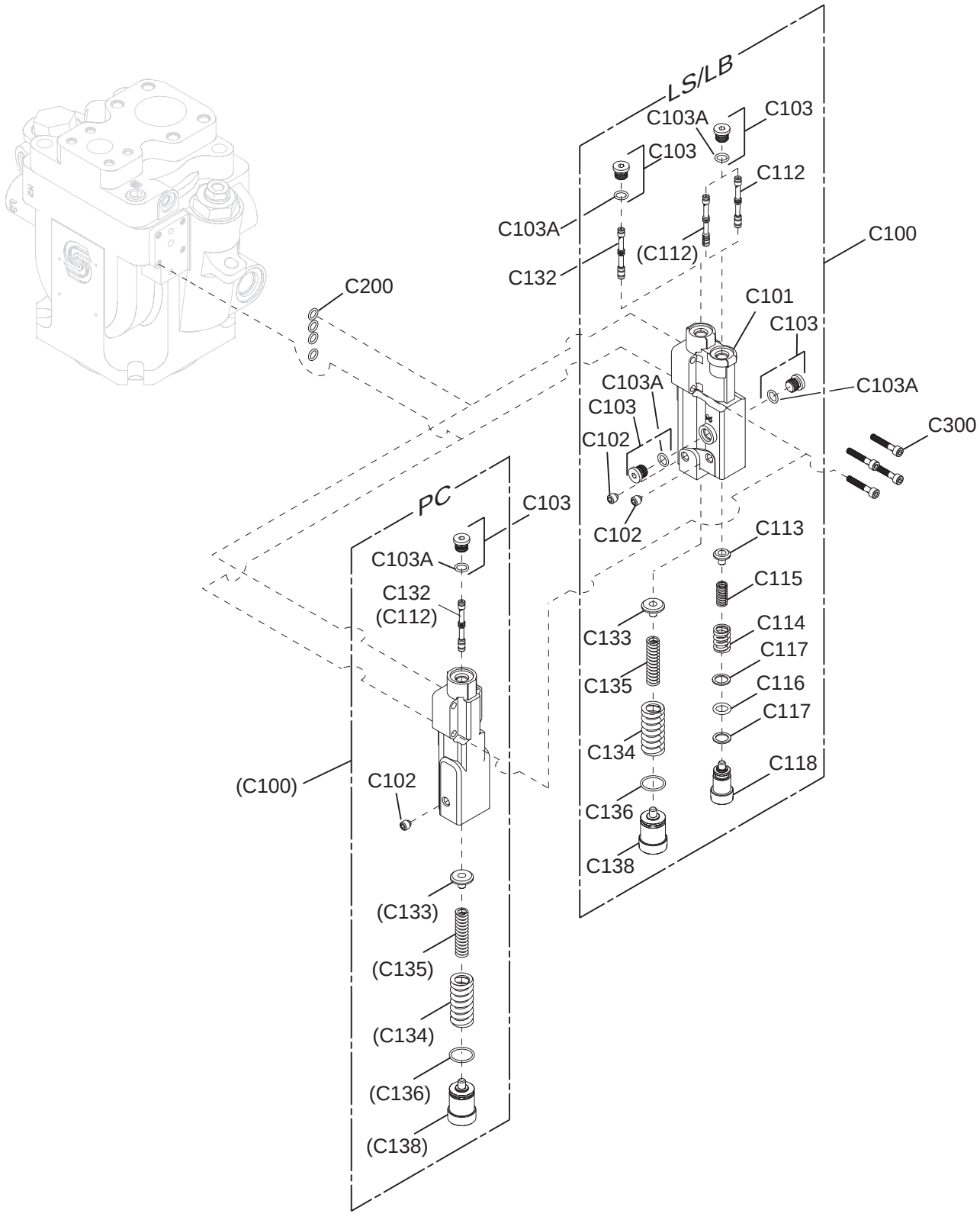
P101 063

10.2 74 cc Frame Size (continued)

Parts List

Item	Description	Qty.
Displacement Limiter		
L010	Servo piston	1
L020	Plug	1
L020A	O-ring	1
L030	Seal nut	1
L040	Set screw	1
Shaft Seal/Housing/Speed Sensing		
K010	Snap ring	1
K020	Lip seal	1
K100	O-ring	1
K110	Back up ring	1
K120	Plug	2
K120A	O-ring	2
K130	Plug	2
K130A	O-ring	2
Auxiliary		
J040	Plug	2
J040A	O-ring	2
J030	Cap screw	4
Common Parts Group		
B081	Bias piston guide	1
B082	O-ring	1
B083	Spring	1
B084	Bias piston	1

10.2 74 cc Frame Size (continued)



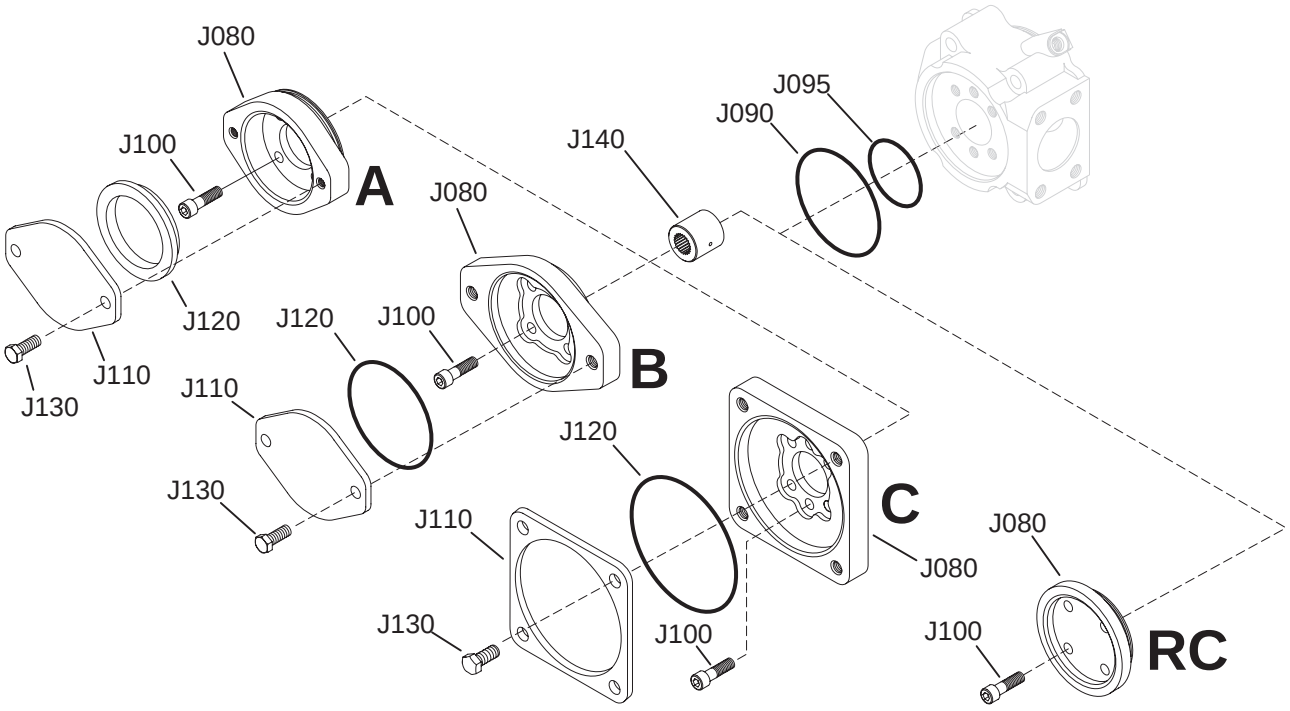
E101 000

10.2 74 cc Frame Size (continued)

Parts List

Item	Description	Qty.
LS / PC Control Assembly		
C100	Control Assembly	1
C101	Housing - Control	1
C102	Set Screw	2
C103	Plug	4
C103A	O-ring	4
C112	Spool - LB/LS	1
C113	Guide - LB/LS Spring	1
C114	Spring - LB/LS Outer	1
C115	Spring - LB/LS Inner	1
C116	O-Ring	1
C117	Ring - Back Up, Packing	2
C118	Plug - LB/LS Adjusting	1
C132	Spool - Control	1
C133	Guide - PC Spring	1
C134	Spring - PC Outer	1
C135	Spring - PC Inner	1
C136	O - Ring	1
C138	Plug - PC Adjusting	1
C200	O - Ring	4
C300	Screw	4

10.3 Auxiliary Pad Adapters



E101 019

10.3 Auxiliary Pad Adapters (continued)

Parts List

Item	Description	Qty.
Auxiliary Pad Adapters		
J090	O-ring	1
J095	O-ring	1
J140	Coupling	1
J080	Adapter flange	1
J100	Screw	4(6)*
J120	Cover seal	1
J110	Cover plate	1
J130	Screw	2(4)*

* SAE C pad

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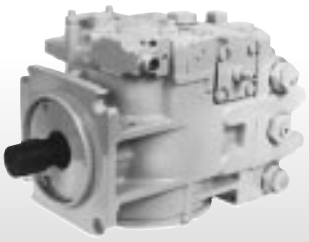
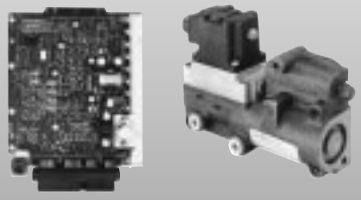


Heavy Duty Axial Piston Pumps and Motors

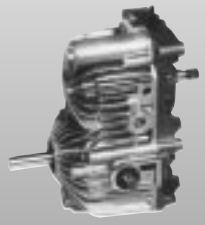
Heavy Duty Bent Axis Variable Motors

Cartridge Motors/ Compact Wheel Drives

Medium Duty Axial Piston Pumps and Motors

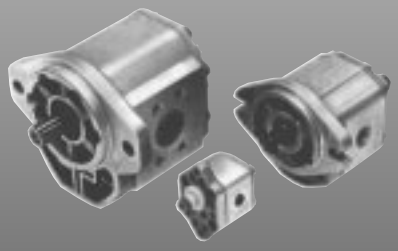


Microcontrollers and Electrohydraulic Controls

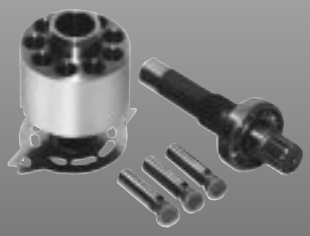


Hydrostatic Transmission Packages

Open Circuit Axial Piston Pumps



Gear Pumps and Motors



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BLN-10129 • Revision A • August 1999